Energy 101

Energy Technology and Policy

New User Guide

Contents

The Energy 101 Story

Energy 101, one of the flagship products of DISCO Learning Media, was developed from an award-winning semester-long course offered at the University of Texas at Austin (UT Austin) titled "Energy Technology & Policy." The class has been offered since 2007 to a mix of engineering, business, policy, and geosciences students. In 2013, a team that included DISCO's founding members converted the class from a traditional direct-instruction format to a massive open online course (MOOC) through UT's partnership with online course provider edX. In the initial offering, more than 44,000 students from around the world enrolled, and nearly 5,000 completed the 10-week course, both of which are records for energy offerings.

In 2013, a survey was sent to students who had completed the course and the team received approximately 1,000 responses. Feedback included requests for a take-home course and as demand grew the course app was born. From February to August 2014, the DISCO team, still working through UT, converted the online course into a full-length, interactive reference course app that combined the multimedia and interactive components of the MOOC with original text. The app starts with energy basics, then includes a survey of the various energy sources, end-use sectors, and cross-cutting elements such as food, water, policy, and the economy.

In August 2014, the app was released to the public and was immediately adopted for courses at Stanford University, Duke University, and the University of Texas at Austin. To date, the app has been adopted by The Energy Institute High School, The University of Maryland, The University of Calgary, Colorado State University, The University of Texas Permian Basin, and the U.S. State Department. It has also been adopted by major corporations such, as Deloitte and ExxonMobil, as required and recommended reading, respectively.

The *Energy 101* digital platform invites rapid and continual updating and evolution to maintain its timeliness and relevance. In 2016, two chapters were added on energy policy. Future chapters will be added on energy storage, the midstream sector, energy security, and energy geography. The flexibility of the content means the resource can be modularized and easily placed in a variety of courses and online learning platforms for maximum reach.

Energy 101 has been featured in *The New York Times* and *Forbes*, and the digital platform is compatible with desktop and mobile devices.

About the Author

Michael E. Webber is the Josey Centennial Professor in Energy Resources in the Mechanical Engineering department at the University of Texas at Austin, where he trains a new generation of energy leaders through research and education at the intersection of engineering, policy, and commercialization. Webber is also the Chief Science and Technology Officer at ENGIE, a global energy and infrastructure services company headquartered in Paris, France.

Energy 101 Contents

Energy 101 Benefits

Comprehensive Content: Contains 32 chapters in 8 sections covering energy from the basics, its uses, and its impact on society.

Interactive Graphs: Charts feature interactive features, helping you understand the data behind them better.

Web App: *Energy 101* integrates facts, tables, video, interactive graphics, and animation, all in a responsive, easy-to-read site.

Professional Development: Professional education for fluency in the technologies, fuels, environmental impacts, policies, and interdisciplinary factors of energy.

Learning Objectives

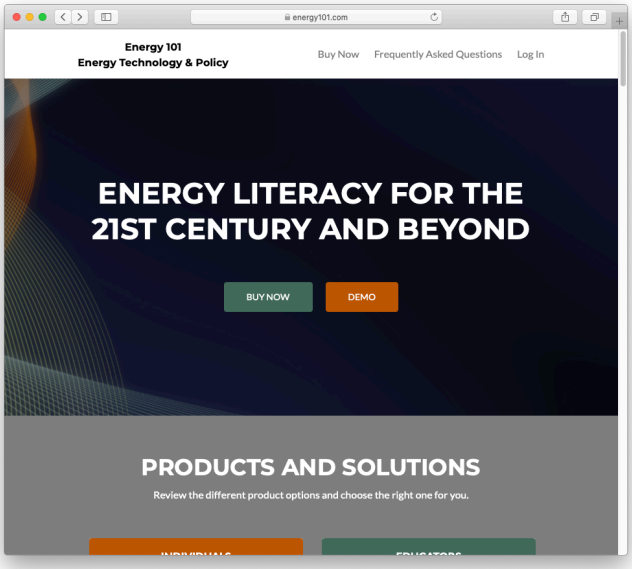
1. Recall and define terminology, units, and magnitudes common in discussions of energy.
2. Identify the primary sources of energy.
3. Recognize how energy is connected across sectors.
4. Recognize different technologies used for energy production and consumption.
5. Interpret the basic laws of thermodynamics.
6. Generalize how energy needs, sources and uses have changed over time.
7. Relate energy issues and society including economics, national security, and the environment.
8. Interpret data, industry reports, and government publications on energy.
9. Identify geographic trends in energy production and consumption.

Science Concepts

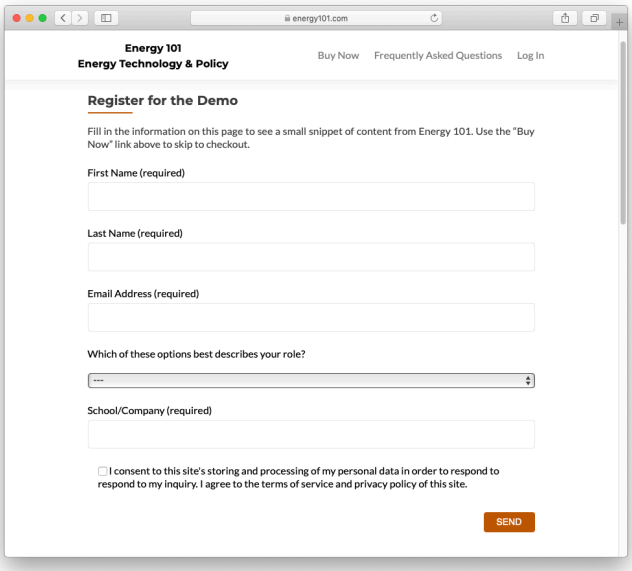
- The interrelationships among the resources within the local environmental system
- The sources and flow of energy through an environmental system
- The impact of human activities on the environment

Viewing the Energy 101 Demo

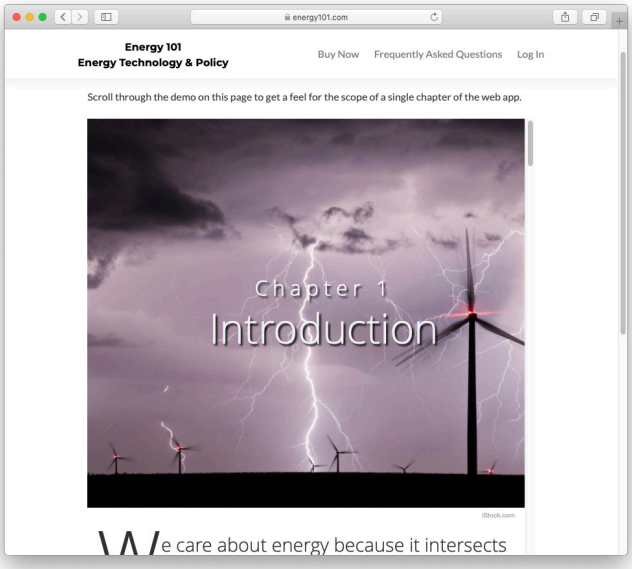
1. To view the demo, select **DEMO** from the home page.



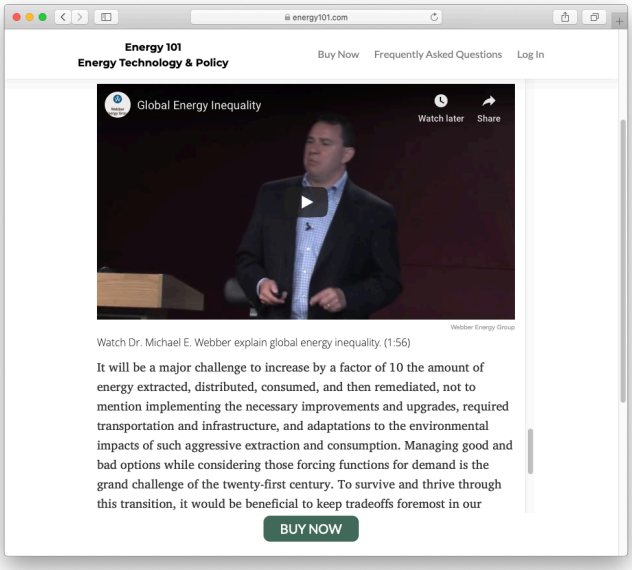
2. Fill out the required information and select **SEND** at the bottom of the page.



3. Scroll through the demo to get a feel for the scope of what a chapter includes.

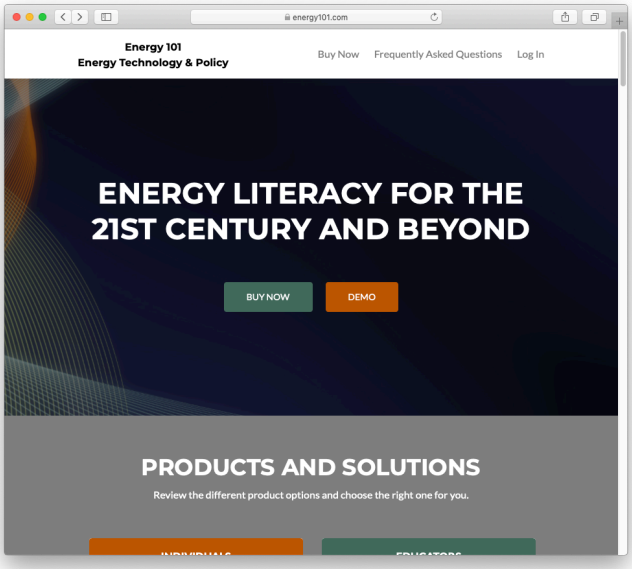


4. To register for the site, select **BUY NOW** at the bottom of the page.



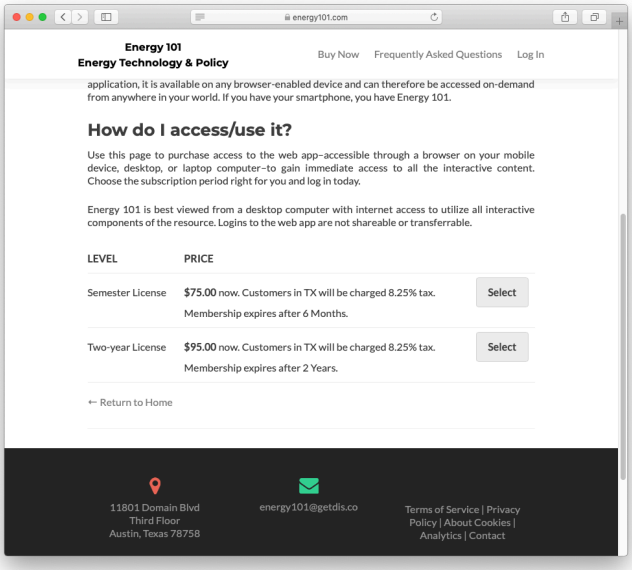
Buying an Energy 101 Subscription

1. To register for the site, select **Buy Now** from the top menu of any page.

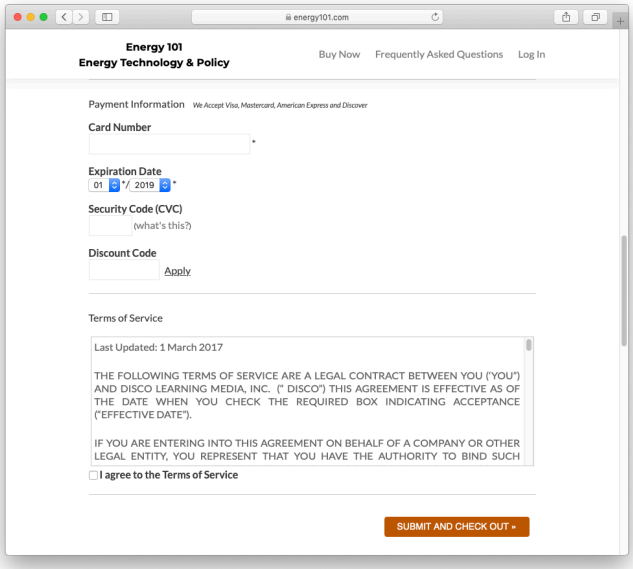


2. If you aren't ready to select a plan, select **Return to Home** at the bottom of the page.

3. Choose the license level that you want to register for — **Semester License** or **Two-year License** — and click the corresponding **Select** button.

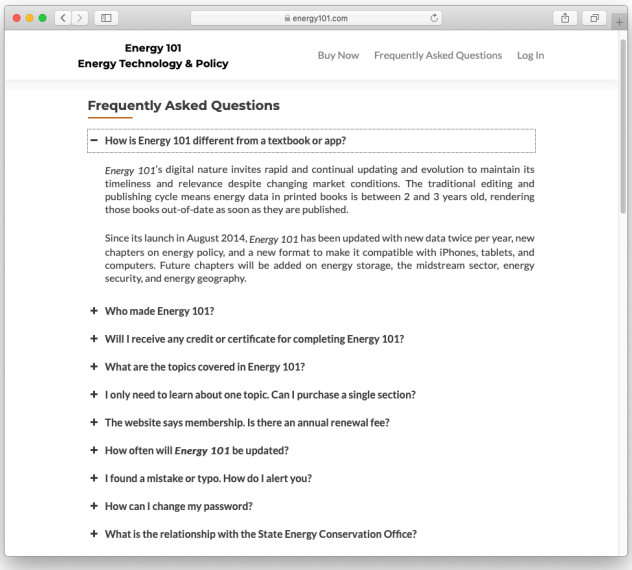


4. Fill out the form with the required information and select **SUBMIT AND CHECK OUT** at the bottom of the page.

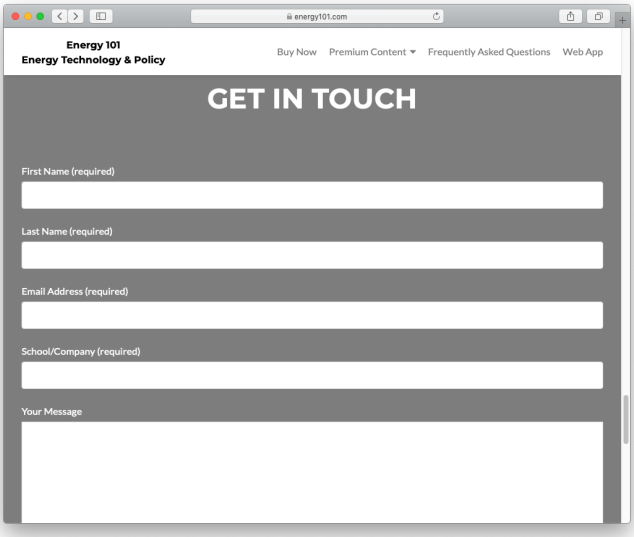


Viewing the FAQ

1. To view the Frequently Asked Questions and their answers, select **Frequently Asked Questions** from the top menu, then scroll through the page.

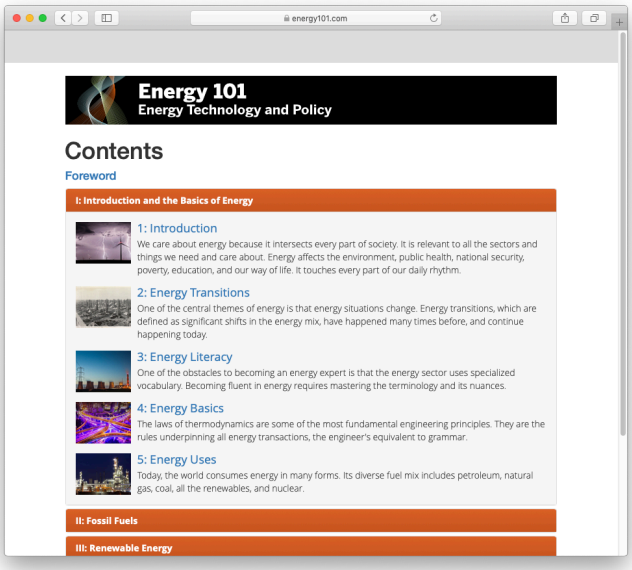


2. If you have a question that is not answered on the FAQs page, fill out the contact form with your questions and select **Send**. A member of our team will get back to you as quickly as possible.

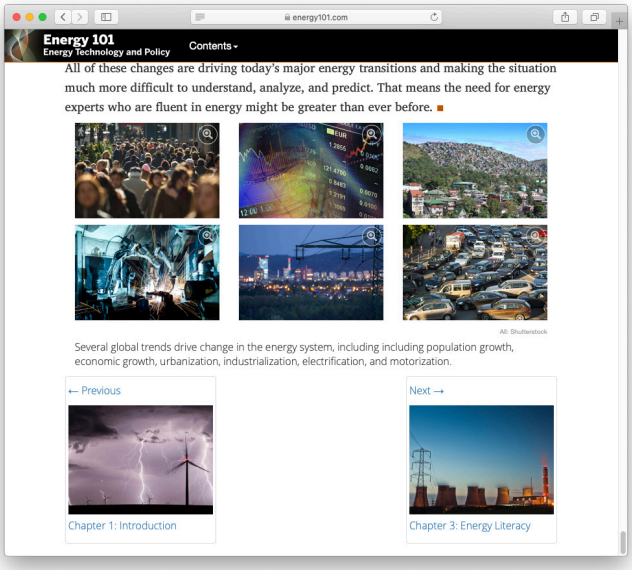


Navigating the Sections and Chapters

1. After logging in with your user name and password, you should see the table of contents. You can select any section and chapter.

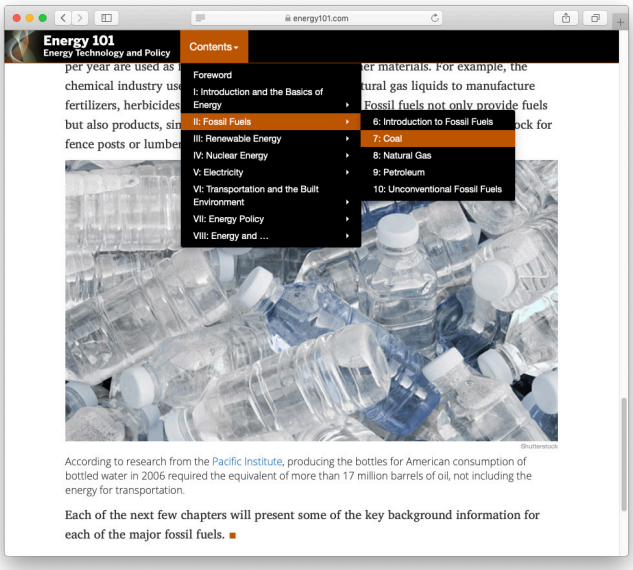


2. Within each chapter you can easily navigate to the previous or next chapter by selecting **Previous** or **Next** at the bottom of the page.



3. In any chapter you can navigate to a different section or chapter by selecting **Contents** in the top menu.

4. To select a chapter, select the section it is in, then select the chapter you want to view. In the example below, the *Coal* chapter in the *Fossil Fuels* section is selected.



5. You can navigate back to the table of contents page from any page by selecting the Energy 101 logo at the top of the page.

6. You can navigate back to the energy101.com home page by selecting the Energy 101 logo at the top of the Contents page.

AP Environmental Science Topics

- Land and Water Use
- Mining
- Global Economics
- Energy Resources and Consumption
- Energy Concepts
- Energy Consumption
- Fossil Fuels
- Nuclear Energy
- Hydroelectric Power
- Energy Conservation
- Renewable Energy
- Pollution
- Pollution Types
- Impacts on Environment and Health
- Economic Impacts

Texas Essential Knowledge and Skills (TEKS) Alignment

(Applies to Texas schools only)

Chapter	TEKS
3: Energy Literacy	IPC.3B, IPC.3C, PHYS.3B, IPC.3C, IPC.5H
4: Energy Basics	IPC.5D, PHYS.6D, PHYS.6E, CHEM.11A, IPC.5A, IPC.5B, PHYS.6B
5: Energy Uses	PHYS.3C, IPC.3F
7: Coal	IPC.5I
8: Natural Gas	IPC.5I
9: Petroleum	IPC.5I
10: Unconventional Fossil Fuels	IPC.5I
12: Hydroelectric	IPC.5I, PHYS.6C
13: Wind	IPC.5I, PHYS.6C
14: Solar	IPC.5I
15: Geothermal	IPC.5I
16: Bioenergy	IPC.5I
17: Nuclear	IPC.5I, IPC.7E, CHEM.12B, PHYS.8D
28: Energy and the Environment	IPC.3A, PHYS.3A, IPC.6A, IPC.7F
29: Energy and Climate Change	IPC.3A, PHYS.3A
30: Energy and Water	IPC.7F

Energy 101 Glossary

Aerosols: Solid or liquid particles suspended within the atmosphere.

Anthropogenic Emissions: Emissions of greenhouse gasses resulting from human activities.

Baselines: The baseline estimates of population, GDP, energy use and hence resultant greenhouse gas emissions without climate policies, determine how big a reduction is required, and also what the impacts of climate change without policy will be.

Capital Stock: Existing investments in energy plant and equipment that may or may not be modified once installed.

Carbon Dioxide (CO_2): CO_2 is a colorless, odorless, non-poisonous gas that is a normal part of the ambient air. Of the six greenhouse gases normally targeted, CO_2 contributes the most to human-induced global warming. Human activities such as fossil fuel combustion and deforestation have increased atmospheric concentrations of CO_2 by approximately 30 percent since the industrial revolution. CO_2 is the standard used to determine the "global warming potentials" (GWPs) of other gases. CO_2 has been assigned a 100-year GWP of 1 (i.e., the warming effects over a 100-year time frame relative to other gases).

Carbon Dioxide Equivalent (CO_2e): Carbon Dioxide Equivalent (CO_2e). The emissions of a gas, by weight, multiplied by its "global warming potential."

Carbon Taxes: A surcharge on the carbon content of oil, coal, and gas that discourages the use of fossil fuels and aims to reduce carbon dioxide emissions.

Chlorofluorocarbons (CFCs): CFCs are synthetic industrial gases composed of chlorine, fluorine, and carbon. They have been used as refrigerants, aerosol propellants, cleaning solvents and in the manufacture of plastic foam. There are no natural sources of CFCs. CFCs have an atmospheric lifetime of decades to centuries, and they have 100-year "global warming potentials" thousands of times that of CO_2, depending on the gas. In addition to being greenhouse gases, CFCs also contribute to ozone depletion in the stratosphere and are controlled under the Montreal Protocol.

Climate: The long-term average weather of a region including typical weather patterns, the frequency and intensity of storms, cold spells, and heat waves. Climate is not the same as weather.

Climate Change: Refers to changes in long-term trends in the average climate, such as changes in average temperatures. In IPCC usage, climate change refers to any change in climate over time, whether due to natural variability or as a result of human activity. In UNFCC usage, climate change refers to a change in climate that is attributable directly or indirectly to human activity that alters atmospheric composition.

Emissions: The release of substances (e.g., greenhouse gases) into the atmosphere.

Emissions Cap: A mandated restraint in a scheduled timeframe that puts a "ceiling" on the total amount of anthropogenic greenhouse gas emissions that can be released into the atmosphere. This can be measured as gross emissions or as net emissions (emissions minus gases that are sequestered).

Emissions Trading: A market mechanism that allows emitters (countries, companies or facilities) to buy emissions from or sell emissions to other emitters. Emissions trading is expected to bring down the costs of meeting emission targets by allowing those who can achieve reductions less expensively to sell excess reductions (e.g. reductions in excess of those required under some regulation) to those for whom achieving reductions is more costly.

Energy Resources: The available supply and price of fossil and alternative resources will play a huge role in estimating how much a greenhouse gas constraint will cost. In the U.S. context, natural gas supply (and thus price) is particularly important, as it is expected to be a transition fuel to a lower carbon economy.

GDP: Gross Domestic Product, a measure of overall economic activity.

Global Warming: The progressive gradual rise of the Earth's average surface temperature thought to be caused in part by increased concentrations of GHGs in the atmosphere.

Global Warming Potential (GWP): A system of multipliers devised to enable warming effects of different gases to be compared. The cumulative warming effect, over a specified time period, of an emission of a mass unit of CO_2 is assigned the value of 1. Effects of emissions of a mass unit of non-CO_2 greenhouse gases are estimated as multiples. For example, over the next 100 years, a gram of methane (CH_4) in the atmosphere is currently estimated as having 23 times the warming effect as a gram of carbon dioxide; methane's 100-year GWP is thus 23. Estimates of GWP vary depending on the time-scale considered (e.g., 20-, 50-, or 100-year GWP), because the effects of some GHGs are more persistent than others.

Greenhouse Effect: The insulating effect of atmospheric greenhouse gases (e.g., water vapor, carbon dioxide, methane, etc.) that keeps the Earth's temperature about 60°F warmer than it would be otherwise.

Greenhouse Gas (GHG): Any gas that contributes to the "greenhouse effect."

Hydrofluorocarbons (HFCs): HFCs are synthetic industrial gases, primarily used in refrigeration and semi-conductor manufacturing as commercial substitutes for chlorofluorocarbons (CFCs). There are no natural sources of HFCs. The atmospheric lifetime of HFCs is decades to centuries, and they have 100-year "global warming potentials" thousands of times that of CO_2, depending on the gas. HFCs are among the six greenhouse gases to be curbed under the Kyoto Protocol.

IPCC: The Intergovernmental Panel on Climate Change (IPCC) is the United Nations body for assessing the science related to climate change.

Kyoto Protocol: The Kyoto Protocol is an international treaty which extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits state parties to reduce greenhouse gas emissions, based on the scientific consensus that (part one) global warming is occurring and (part two) it is extremely likely that human-made CO_2 emissions have predominantly caused it.

Market Benefits: Benefits of a climate policy that can be measured in terms of avoided market impacts such as changes in resource productivity (e.g., lower agricultural yields, scarcer water resources) and damages to human-built environment (e.g., coastal flooding due to sea-level rise).

Methane (CH_4): CH_4 is among the six greenhouse gases to be curbed under the Kyoto Protocol. Atmospheric CH_4 is produced by natural processes, but there are also substantial emissions from human activities such as landfills, livestock and livestock wastes, natural gas and petroleum systems, coalmines, rice fields, and wastewater treatment. CH_4 has a relatively short atmospheric lifetime of approximately 10 years, but its 100-year GWP is currently estimated to be approximately 23 times that of CO_2.

Nitrous Oxide (N_2O): N_2O is among the six greenhouse gases to be curbed under the Kyoto Protocol. N_2O is produced by natural processes, but there are also substantial emissions from human activities such as agriculture and fossil fuel combustion. The atmospheric lifetime of N_2O is approximately 100 years, and its 100-year GWP is currently estimated to be 296 times that of CO_2.

Perfluorocarbons (PFCs): PFCs are among the six types of greenhouse gases to be curbed under the Kyoto Protocol. PFCs are synthetic industrial gases generated as a by-product of aluminum smelting and uranium enrichment. They also are used as substitutes for CFCs in the manufacture of semiconductors. There are no natural sources of PFCs. PFCs have atmospheric lifetimes of thousands to tens of thousands of years and 100-year GWPs thousands of times that of CO_2, depending on the gas.

ppm or ppb: Abbreviations for "parts per million" and "parts per billion," respectively - the units in which concentrations of greenhouse gases are commonly presented. For example, since the pre-industrial era, atmospheric concentrations of carbon dioxide have increased from 270 ppm to 370 ppm.

Radiative Forcing: The term radiative forcing refers to changes in the energy balance of the earth-atmosphere system in response to a change in factors such as greenhouse gases, land-use change, or solar radiation. The climate system inherently attempts to balance incoming (e.g., light) and outgoing (e.g. heat) radiation. Positive radiative forcings increase the temperature of the lower atmosphere, which in turn increases temperatures at the Earth's surface. Negative radiative forcings cool the lower atmosphere. Radiative forcing is most commonly measured in units of watts per square meter (W/m^2).

Renewable Energy: Energy obtained from sources such as geothermal, wind, photovoltaic, solar, and biomass.

Sulfur Hexafluoride (SF_6): SF_6 is among the six types of greenhouse gases to be curbed under the Kyoto Protocol. SF_6 is a synthetic industrial gas largely used in heavy industry to insulate high-voltage equipment and to assist in the manufacturing of cable-cooling systems. There are no natural sources of SF_6. SF_6 has an atmospheric lifetime of 3,200 years. Its 100-year GWP is currently estimated to be 22,200 times that of CO_2.

Trace Gas: A term used to refer to gases found in the Earth's atmosphere other than nitrogen, oxygen, argon and water vapor. When this terminology is used, carbon dioxide, methane, and nitrous oxide are classified as trace gases. Although trace gases taken together make up less than one percent of the atmosphere, carbon dioxide, methane and nitrous oxide are important in the climate system. Water vapor also plays an important role in the climate system; its concentrations in the lower atmosphere vary considerably from essentially zero in cold dry air masses to perhaps 4 percent by volume in humid tropical air masses.

UNFCCC: The United Nations Framework Convention on Climate Change is an international environmental treaty adopted on 9 May 1992 and opened for signature at the Earth Summit in Rio de Janeiro from 3 to 14 June 1992.

Water Vapor (H_2O): Water vapor is the primary gas responsible for the greenhouse effect. It is believed that increases in temperature caused by anthropogenic emissions of greenhouse gases will increase the amount of water vapor in the atmosphere, resulting in additional warming.

Weather: Describes the short-term (i.e., hourly and daily) state of the atmosphere. Weather is not the same as climate.

Contact Us

energy101@getdis.co
11801 Domain Blvd, Third Floor, Austin, Texas 78758

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TEXAS

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