

## ***GLOBAL WARMING:*** Facts and Our Future

### **Introduction**

Global warming and its potential harmful impacts are pressing issues facing scientists and policy makers all over the world. In this activity, you are being called into action by the United Nations to examine the causes and potential impacts of global warming and to develop policy recommendations for adoption by UN member nations. You serve as an expert member of a climate action team working on global warming issues. Your team will investigate the following questions:

- Is the climate warming?
- What role, if any, do humans have in contributing to climate change?
- What policy choices can be made to respond to global warming?



The UN has asked that you pay special attention to sustainable energy and the production of greenhouse gases. While much is now known about climate change and energy use, there are still many questions that need to be answered and decisions that will have to be made in order to address the problems associated with global warming.

For this project you will work in groups of five. As a team, you will use the Koshland Science Museum website along with other web-based resources to investigate climate change and global warming. Note that while this scenario is fictitious, many of the questions addressed in this activity are the same questions being considered by real-life climate scientists, economists, policy analysts, energy experts, and urban planners.

## Initial Group Activity

Begin by working as a group to gather background information. First, watch the video from the American Association for the Advancement of Science (AAAS) for an introduction to why climate change is an important issue: [AAAS Video on Climate Change](#)



1. Before you begin your investigation of the changing climate, you should understand the difference between “climate” and “weather.” How is climate different from weather? How are climate and weather related?

[Climate and Weather \(US EPA\)](#)

[What's the Difference Between Weather and Climate? \(NASA\)](#)

2. The UN is concerned that the gas carbon dioxide (CO<sub>2</sub>) may have something to do with recent changes in the climate. What is the greenhouse effect? How is amplified warming different from natural warming?

[The Greenhouse Effect \(BBC\)](#)

[What is the Greenhouse Effect? \(KSM\)](#)

[Living in the Greenhouse \(NCAR\)](#)

3. There are many different factors that contribute to climate change. What factors are most responsible for significant changes in the climate? Which of these are natural causes and which are driven by human activity?

[Causes of Climate Change \(KSM\)](#)

[What on Earth Affects Climate? \(NCAR\)](#)

[Can We Change the Climate? \(US EPA\)](#)

4. Humans, like all species on this planet, will see many alterations in their environment as the global climate changes. How will humans be affected by changes in the climate? How will global warming change ecosystems and the environment?

[Changes in the Climate \(KSM\)](#)

[Impacts of Climate Change \(KSM\)](#)

[See the Impacts \(US EPA\)](#)

5. Explore the Climate Change Mitigation Simulator in the *Earth Lab* exhibit. Develop a strategy portfolio and visualize it. If the U.S. reduces emission alone, in what year does atmospheric GHG concentration exceed recommended levels? How does this compare to the other three visualizations? Develop a second strategy portfolio and compare the two with regard to GHG concentration and global temperature change.

[Climate Change Mitigation Simulator \(KSM\)](#)

## Individual Activity

Now that you have learned about the causes of climate change and the impacts of global warming, more research is needed about how to study and respond to climate change. Each member of the group will now assume a role for the investigative team of experts (Climate Scientist, Policy Analyst, Economist, Energy Expert, and Urban Planner). Each of you will work individually, according to your role, and investigate the issues related to global warming from several different perspectives. When finished with your individual research, you will share what you have learned with your team and prepare a report to be presented to UN officials. Reference the appropriate worksheet to complete this activity.

### The Roles:

- **Climate Scientist:** Investigate the scientific data behind climate change and tools used to study global warming.
- **Policy Analyst:** Learn how laws and public policy can affect climate change.
- **Economist:** Study the economic impacts associated with global warming and see how business leaders are responding to the changing climate.
- **Energy Expert:** Explore how we get energy for transportation and electricity and learn how energy use impacts the climate.
- **Urban Planner:** See how architects, engineers, and city planners are responding to climate change by using sustainable materials and energy efficient designs.

## Summary Group Activity

After each member of the group has completed the individual worksheets, the group should prepare a report and/or a presentation describing your policy recommendations to the United Nations. See the relevant worksheet to complete the group activity.

## Climate Scientist

1. What kind of training and education do you need to become a climate scientist? What kind of activities do climate scientists do on a day-to-day basis?

[Ask a State Climatologist \(Washington Post\)](#)

[Careers in Earth Science - Atmospheric Scientist \(NASA\)](#)

[A Career Guide for the Atmospheric Sciences \(AMS\)](#)

[Environmental Programs and Career Specialties \(Enviro Education\)](#)



2. Science is a collaborative effort. What are some of the ways in which scientists are working together to study and report on global warming?

[Intergovernmental Panel on Climate Change \(IPCC\)](#)

[Informing an Effective Response to Climate Change \(NAS\)](#)

[Climate Change: Evidence, Impacts, and Choices \(NAS\)](#)

[Joint Science Academies' Statement: Global Response to Climate Change \(NAS\)](#)



3. a) What is "proxy data"? What are some of the sources of proxy data that scientists use to study climate change?

[Climate Modeling and Trends \(KSM\)](#)

[Paleoclimatology: How Can We Infer Past Climates? \(Carlton College\)](#)

[Long Ago Climates \(NCAR\)](#)

b) How far can scientists go back in time and still have confidence in the climate record?

[Surface Temperature Reconstructions \(NAS\)](#)

4. Scientists have used proxy data sources to reconstruct climate conditions over the past half-million years. Examine the historical and present climate data.

a) What is the relationship between CO<sub>2</sub> and temperature? Before modern times, what were the highest levels of CO<sub>2</sub> recorded?

[Climate Modeling and Trends \(KSM\)](#)

[Causes of Climate Change \(KSM\)](#)

[Change in the Climate \(KSM\)](#)



b) What are the most recent CO<sub>2</sub> levels measured?

[Trends in Atmospheric Carbon Dioxide \(NOAA\)](#)

5. Climate scientists use complicated computer models to better understand the climate and predict climate change in the future. What have these models told us about future climate change? What are some of the factors that cause different models to produce different projections?

[Climate Modeling 101 \(NAS\)](#)

[Causes of Climate Change \(KSM\)](#)

[Impacts of Climate Change \(KSM\)](#)

[The Basics of Climate Prediction \(Oxford University\)](#)

[Simulating the Earth's Climate \(Lawrence Livermore National Laboratory\)](#)



## Climate Scientist Fact Finding Sheet



1. What kind of training and education do you need to become a climate scientist? What kind of activities do climate scientists do on a day-to-day basis?

2. Science is a collaborative effort. What are some of the ways in which scientists are working together to study and report on global warming?

3. a) What is "proxy data"? What are some of the sources of proxy data that scientists use to study climate change? b) How far can scientists go back in time and still have confidence in the climate record?

4. Scientists have used proxy data sources to reconstruct climate conditions over the past half-million years. Examine the historical and present climate data.

a) What is the relationship between CO<sub>2</sub> and temperature? Before modern times, what were the highest levels of CO<sub>2</sub> recorded? b) What are the most recent CO<sub>2</sub> levels measured?

5. Climate scientists use complicated computer models to better understand the climate and predict climate change in the future. What have these models told us about future climate change? What are some of the factors that cause different models to produce different projections?

## Policy Analyst

1. What kind of training and education do you need to become a policy analyst? What kind of activities do policy analysts do on a day-to-day basis?

[Environmental Policy - Educational and Career Outlooks \(Enviro Education\)](#)

[Science Policy: Establishing Guidelines, Setting Priorities \(AAAS\)](#)



2. a) Using California as an example, describe some of the state and local policies and initiatives that have been proposed to address climate change.

[Twenty-First Century Environmentalism: How Protecting Our Environment Will Create Economic Growth \(CA Gov. Schwarzenegger\)](#)

[California Incentives for Renewables and Efficiency \(DSIRE, NC State University\)](#)

[Climate Action Team and Climate Initiative \(CA EPA\)](#)

b) Find your state and describe some of the initiatives in your area.

[Database of State Incentives for Renewables and Efficiency \(DSIRE, NC State University\)](#)

[C2ES State Initiatives \(Center for Climate and Energy Solutions\)](#)

3. On the national level, what are some of the federal policies and initiatives that have been proposed to reduce fossil fuel consumption? How do the federal initiatives differ from the state proposals?

[Energy Policy and Systems Analysis \(US Dept. of Energy\)](#)

[Current and Near-Term Greenhouse Gas Reduction Initiatives \(US EPA\)](#)

[Global Warming \(Union of Concerned Scientists\)](#)

[Global Climate Change \(US State Dept.\)](#)

4. What are some of the major international policy efforts aimed at global warming issues? How do the efforts differ?

[The European Climate Change Program \(European Commission\)](#)

[The United Nations Framework Convention on Climate Change \(United Nations\)](#)

[Kyoto Protocol \(United Nations\)](#)

[Kyoto Protocol Countries \(United Nations\)](#)

[Asia-Pacific Partnership on Clean Development and Climate](#)

[Asia-Pacific Partnership on Clean Development and Climate Action Plans](#)

**Policy Analyst  
Fact Finding Sheet**



1. What kind of training and education do you need to become a policy analyst? What kind of activities do policy analysts do on a day-to-day basis?

2. a) Using California as an example, describe some of the state and local policies and initiatives that have been proposed to address climate change. b) Find your state and describe some of the initiatives in your area.

3. On the national level, what are some of the federal policies and initiatives that have been proposed to reduce fossil fuel consumption? How do the federal initiatives differ from the state proposals?

4. What are some of the major international policy efforts aimed at global warming issues? How do the efforts differ?

## Economist



1. What kind of training and education do you need to become an economist? What kind of activities do economists do on a day-to-day basis?

[Environmental Economics - Educational and Career Outlooks \(Environmental Programs\)](#)

2. What are some of the predicted economic costs associated with a warming climate? What parts of the world are expected to be hardest hit from an economic perspective because of global warming?

[Economic Costs of Sea Level Rise \(IPCC\)](#)

[Stern Review: The Economics of Climate Change \(HM Treasury - UK\)](#)

[Climate Change Futures: Health, Ecological and Economic Dimensions \(UNDP\)](#)

3. The ways in which countries and businesses respond to global warming are bound to impact national and international economies. What are some of the options being proposed for businesses as they try to reduce their greenhouse gas emissions? How are different countries trying to lessen the negative economic impacts associated with reducing greenhouse gas emissions on a national level?

[Case Studies \(The Climate Group\)](#)

[European Union Emissions Trading Scheme \(Wikipedia\)](#)

[Carbon Tax vs. Emissions Trading \(Global Policy Forum\)](#)

[Greenhouse gas emissions article archive \(NY Times\)](#)

[Climate Change Topic Index \(The Economist\)](#)



4. How can an individual calculate his or her "carbon footprint"? What are some of the economic choices that individuals can make to reduce their carbon footprint? How do companies offset an individual's carbon impact?

[Carbon Footprint Calculator \(NativeEnergy.com\)](#)

[Responses to Climate Change \(KSM\)](#)

[Carbon Fund \(Carbonfund.org\)](#)

**Economist  
Fact Finding Sheet**



1. What kind of training and education do you need to become an economist? What kind of activities do economists do on a day-to-day basis?

2. What are some of the predicted economic costs associated with a warming climate? What parts of the world are expected to be hardest hit from an economic perspective because of global warming?

3. The ways in which countries and businesses respond to global warming are bound to impact national and international economies. What are some of the options being proposed for businesses as they try to reduce their greenhouse gas emissions? How are different countries trying to lessen the negative economic impacts associated with reducing greenhouse gas emissions on a national level?

4. How can an individual calculate his or her "carbon footprint"? What are some of the economic choices that individuals can make to reduce their carbon footprint? How do companies offset an individual's carbon impact?

## Energy Expert

1. What kind of training and education do you need to become an energy expert? What kind of activities do energy experts do on a day-to-day basis?

[Jobs in Green Science \(AAAS\)](#)

[Energy Careers and Jobs \(US Dept. of Energy\)](#)

[Energy Studies: Academic Requirements, Professional Outlook \(Environmental Programs\)](#)



2. What are some alternative transportation technologies under development that reduce fossil fuel consumption? Which options are available where you live?

[Alternative Fuels Data Center \(US Dept. of Energy\)](#)

[Advanced Vehicles and Fuels Basics \(NREL\)](#)

[Hybrid Cars Cribsheet \(Seed Magazine\)](#)

[Fill 'er Up - A Grist Special Series on Biofuels \(grist.org\)](#)

[Hydrogen Fuel Cells \(NOVA\)](#)

[Alternative Energy Resources by State \(US Dept. of Energy\)](#)

[Database of State Incentives for Renewables and Efficiency \(DSIRE, NC State University\)](#)

3. What are some of the alternative energy technologies being developed to reduce fossil fuel consumption in producing electricity? Which options are available where you live?

[Responses to Climate Change \(KSM\)](#)

[Learning About Renewable Energy \(NREL\)](#)

[Green Power Locator \(US EPA\)](#)

[Alternative Energy Resources by State \(US Dept. of Energy\)](#)

[Database of State Incentives for Renewables and Efficiency \(DSIRE, NC State University\)](#)

4. Choose two alternative energy sources and list the benefits and drawbacks for each.

General information about energy:

[Energy Facts \(US Dept. of Energy\)](#)

[The Energy Story \(CA Energy Commission\)](#)

[Energy Sources \(US Dept. of Energy\)](#)

Wind:

[Wind Power Technologies \(US Dept. of Energy\)](#)

[Wind With Miller \(Windpower.org\)](#)

[How Wind Energy Works \(UCS\)](#)

Solar:

[Solar Powering America Home \(US Dept. of Energy\)](#)

[Solar Basics \(CA Energy Commission\)](#)

[How Solar Energy Works \(UCS\)](#)



Ocean:

[Water Energy \(US Dept. of Energy\)](#)

[Ocean Energy \(CA Energy Commission\)](#)

Hydroelectric:

[Water Power Program \(US Dept. of Energy\)](#)

[How Hydrokinetic Energy Works \(UCS\)](#)



Geothermal:

[Geothermal Technologies \(US Dept. of Energy\)](#)

[What is Geothermal? \(geothermal.org\)](#)

[How Geothermal Energy Works \(UCS\)](#)



Nuclear:

[Nuclear Power Cribsheet \(Seed Magazine\)](#)

[Nuclear Energy Overview \(CA Energy Commission\)](#)

[Why Nuclear Energy? \(Nuclear Energy Institute\)](#)

[Nuclear Power Education \(nuclearinfo.net\)](#)



Biomass:

[Bioenergy Technologies \(US Dept. of Energy\)](#)

[How Biomass Energy Works \(UCS\)](#)

**Energy Expert  
Fact Finding Sheet**



1. What kind of training and education do you need to become an energy expert? What kind of activities do energy experts do on a day-to-day basis?

2. What are some alternative transportation technologies under development that reduce fossil fuel consumption? Which options are available where you live?

3. What are some of the alternative energy technologies being developed to reduce fossil fuel consumption in producing electricity? Which options are available where you live?

4. Choose two alternative energy sources and list the benefits and drawbacks for each.

## Urban Planner

1. What kind of training and education do you need to become an urban planner? What kind of activities do urban planners do on a day-to-day basis?

[What is Planning? \(American Planning Association\)](#)

[How to Become an Architect \(About.com\)](#)

[Career Stages \(American Institute of Architecture\)](#)

[Urban and Regional Planning - Professional Outlook \(Environmental Programs\)](#)



2. What kinds of technologies, materials, and design elements are urban planners using to make buildings and communities more energy efficient?



[Architects and Climate Change PDF \(American Institute of Architecture\)](#)

[Creating Livable Sustainable Communities \(newurbanism.org\)](#)

[Building Technologies Program \(US Dept. of Energy\)](#)

[Sustainability Plan for the City of San Francisco \(SustainableCity.org\)](#)

3. What are some of the technologies, materials, and design elements available to make houses more energy efficient?

[Energy-Efficient Home Design \(US Dept. of Energy\)](#)

[Energy Star \(US Dept. of Energy and EPA\)](#)

[Building Technologies Program \(US Dept. of Energy\)](#)

[Renewable Energy Programs \(CA Energy Commission\)](#)

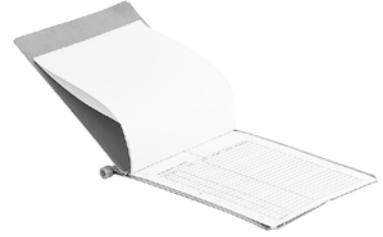
4. What is the urban heat island effect? How can "green rooftops" help address problems associated with the urban heat island effect?

[Heat Island Effect \(US EPA\)](#)

[About Green Roofs \(Green Roofs for Healthy Cities\)](#)



**Urban Planner  
Fact Finding Sheet**



1. What kind of training and education do you need to become an urban planner? What kind of activities do urban planners do on a day-to-day basis?

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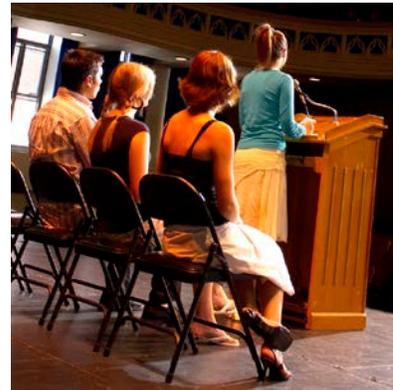
3. What are some of the technologies, materials, and design elements available to make houses more energy efficient?

4. What is the urban heat island effect? How can "green rooftops" help address problems associated with the urban heat island effect?

## Summary Group Activity

After each member of the group has completed researching the individual roles, the group should come together and discuss the following questions:

1. Is the Earth's climate warming? If so, what are the causes and how have human activities contributed to this warming? How confident are scientists about climate change? What kind of information is still needed to bolster understanding of global warming (e.g. environmental impacts, computer models, historical data, economic costs)?



2. What choices do humans have for responding to global climate change? Present the choices available at the personal, state, federal, and international levels. What are the pros and cons associated with these different choices? How will these choices affect the economy, public policy, our lifestyles, and the kinds of technologies used?

3. What policy recommendations do you have for the United Nations member countries? This includes policies regarding scientific research, international treaties, funding new technologies and energy sources, federal legislation, environmental impacts, etc. How will countries from different parts of the world need to respond differently?

Prepare a report and/or a presentation that includes answers to all of the questions. These questions might require further research into the issues. In addition to the references you used individually, you can use the references in the Additional Websites and Resources document.

### Conclusion

Congratulations! You have responded to an urgent need in the international community. Your work may help others to become more aware of the problems associated with global warming, as well as some of the potential solutions.

