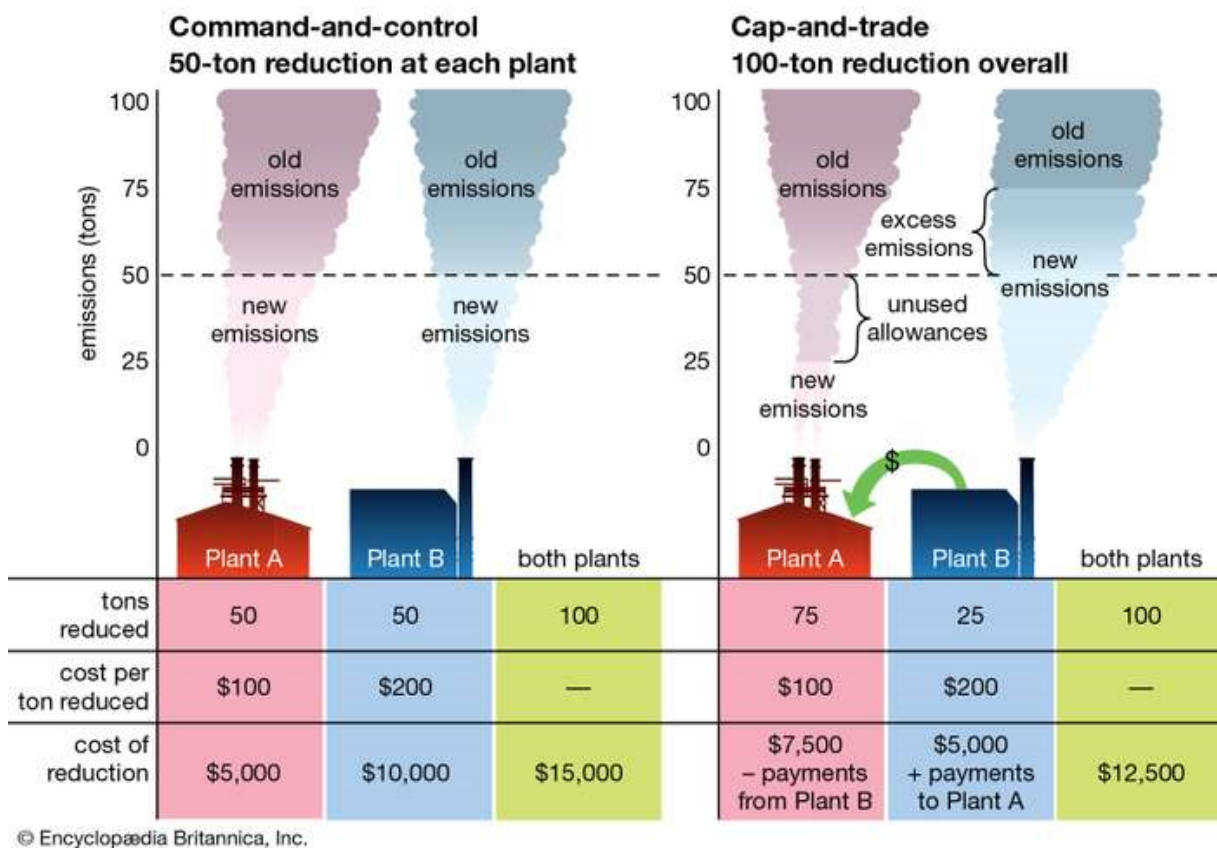


## Permit markets

The concept of using a permit market to control pollution levels was first developed by Canadian economist John Dales and American economist Thomas Crocker in the 1960s. Through this method, pollution permits are issued to firms in an industry where a reduction in emissions is desired. The permits give each firm the right to produce emissions according to the number of permits it holds. However, the total number of permits issued is limited to the amount of pollution that is allowed throughout the industry. This means that some firms will not be able to pollute as much as they would like, and they will be forced to either reduce emissions or purchase permits from another firm in the industry (*see also* emissions trading).



## How emissions trading works

Assume two emitting plants, A and B. Each plant emits 100 tons of pollutants (for a total emission of 200 tons), and the requirement is that these emissions be cut in half, for an overall reduction of 100 tons.

(Left) In a traditional **command-and-control system**, each plant might be required to reduce by 50 percent, or 50 tons, to meet the overall reduction of 100 tons. Plant A might be able to reduce at only \$100 a ton, for a total expenditure of \$5,000. Plant B might have to spend \$200 a ton, for a total of \$10,000. The cost for both plants to reach the overall reduction of 100 tons would therefore

be \$15,000.

(Right) In a **cap-and-trade system**, each plant might be given allowances for only half its previous emissions. Plant A, where reduction costs only \$100 a ton, might be able to reduce emissions to as little as 25 tons, leaving it with unused allowances for 25 tons of pollutants that it is not emitting. Plant B, where reduction costs \$200 a ton, might find it less costly to reduce to only 75 tons and then buy Plant A's unused allowances, effectively paying Plant A to make the 25 tons of reductions that Plant B cannot afford. The overall reduction of 100 tons would still be reached but at a lower overall cost (\$12,500) than under the command-and-control system.

Those firms that can reduce their emissions for the lowest possible cost benefit from this type of regulation. Firms that emit less can sell their permits for an amount greater than or equal to the cost of their own emissions reduction, resulting in profits in the permit market. However, even firms for which it is very costly to reduce pollution experience a cost savings through permit markets, because they can purchase pollution permits at a price that is less than or equal to the taxes or other penalties that they would face if they were required to reduce emissions. Ultimately, permit markets make it less costly for an industry to comply with environmental regulations and, with the prospect of profits in the permit market, this type of regulation provides an incentive for firms to find cheaper pollution-reducing technologies.

Environmentalists have called for the creation of local, regional, and international permit markets to address the problem of carbon emissions coming from industrial facilities and electrical utilities, many of which burn coal to generate electricity. Dales and Crocker argued that applying permit marketing to issues of global warming and climate change, an idea called “cap and trade,” could be most useful in situations where there are a limited number of actors working to solve a discrete pollution problem, such as pollution abatement in a single waterway.

Carbon emissions, however, are produced by numerous utilities and industries in every country. Creating international rules to address global carbon emissions that all actors can abide by has been problematic because rapidly developing countries—such as China and India, which are among the world's largest producers of carbon emissions—view restraints on carbon emissions as impediments to growth. As such, developing a carbon market made up of willing players alone will not solve the problem, since any progress made to staunch carbon emissions by industrialized countries will be offset by those countries that are not part of the agreement.

### **Examples of regulation using corrective instruments**

The implementation of the Clean Air Act of 1970 represented the first major application of the concepts of environmental economics to government policy in the United States, which followed a

command-and-control regulatory framework. This law and its amendments in 1990 set and strengthened strict ambient air quality standards. In some cases, specific technologies were required for compliance. After the Clean Air Act Amendments of 1990, pollution taxes and permit markets became the preferred tools for environmental regulation. Although permit markets had been used in the United States as early as the 1970s, the Clean Air Act Amendments of 1990 ushered in an era of increased popularity for that type of regulation by requiring the development of a nationwide permit market for sulfur dioxide emissions, which, along with laws requiring the installation of filtering systems (or “scrubbers”) on smokestacks and the use of low-sulfur coal, reduced sulfur dioxide emissions in the United States.

Additional programs have been used to reduce ozone-related emissions, including California’s Regional Clean Air Incentives Market (RECLAIM), established in the Los Angeles basin, and the Ozone Transport Commission NO<sub>x</sub> Budget Program, which considers various nitrogen oxide (NO<sub>x</sub>) emissions and spans 12 states in the eastern United States. Both of those programs were originally implemented in 1994. The Ozone Transportation Commission program aimed to reduce nitrogen oxide emissions in participating states in both 1999 and 2003. The results of the program, as reported by the Environmental Protection Agency, included a reduction in sulfur dioxide emissions (as compared with 1990 levels) of more than five million tons, a reduction in nitrogen oxide emissions (as compared with 1990 levels) of more than three million tons, and nearly 100 percent program compliance.

Finland, Sweden, Denmark, Switzerland, France, Italy, and the United Kingdom all made changes to their tax systems in order to reduce pollution. Some of those changes include the introduction of new taxes, such as Finland’s 1990 implementation of a carbon tax. Other changes involve using tax revenue to increase environmental quality, such as Denmark’s use of tax revenue to fund investment in energy-saving technologies.

In the United States, local grocery markets are at the centre of a large tax system aimed at reducing environmental degradation—the **deposit-refund system**, which rewards individuals who are willing to return bottles and cans to an authorized recycling centre. Such an incentive represents a negative tax to individuals in exchange for recycling behaviour that benefits society as a whole.

### **Policy implications**

The policy implications of work done by environmental economists are far-reaching. As countries deal with issues such as water quality, air quality, open space, and global climate change, the methodologies developed in environmental economics are key to providing efficient, cost-effective solutions.

Although command and control remains a common form of regulation, the above sections detail ways that countries have used market-based approaches such as taxation and permit markets. Examples of those types of programs continued to develop in the early 21st century. For example, in an attempt to comply with the provisions of the Kyoto Protocol, which was implemented to control greenhouse gas emissions, the European Union established a carbon dioxide permit market aimed at reducing greenhouse gases.

Even the **Coase theorem** has been applied as global environmental problems demand mutually beneficial agreements to be voluntarily negotiated between countries. The Montreal Protocol, for example, which was implemented to control emissions of ozone-depleting chemicals, uses a multilateral fund that compensates developing countries for the costs incurred in phasing out ozone-depleting chemicals. That approach is very similar to the one in which parents in a community may find it beneficial to compensate a polluting firm for reducing emissions.

### **Future Directions**

Because of its interdisciplinary nature, environmental economics constantly presses forward in many directions, including efforts to realize long-term sustainable development and to bring increased attention to the degradation of resources held in common, such as clean air and water. Many pressing environmental issues involve both local and global pollutants and range from local water quality to the worldwide reduction of greenhouse gas emissions.

In terms of local, regional, and national environmental issues, the application of corrective instruments is quite feasible. However, evaluating the value of regulated environmental goods, as well as the proposed regulatory instruments, remains the topic of ongoing research. One such topic involves the achievement of sustainable development, an approach to economic planning that attempts to foster economic growth while preserving the quality of the environment for future generations. That goal has proven to be difficult to realize over the long term, since long-term sustainability analyses depend on the particular resources being examined. The perpetuation of some environmental goods may lead to the gradual extinction of others. For example, a forest that will provide a sustained yield of timber in perpetuity may not support native bird populations, and a mineral deposit that will eventually be exhausted may nevertheless support more or less sustainable communities.

Global issues have proved to be much more complex because of the number of actors involved and the speculative nature of emerging economic information. In terms of global issues, such as global warming, there was still much work to be done at the beginning of the 21st century regarding the economic impact of changes to Earth's climate. In addition, solutions relying on government enforcement are less possible when it comes to global climate change, because emitters range from

private citizens to large multinational corporations to some of the most-populous countries, all of whom rely on carbon-emitting fossil fuels to power their economic success.

One solution, emphasizing voluntary compliance, arose in the wake of the Kyoto Protocol. Several regional agreements were formed to reduce greenhouse emissions. One such agreement, known as the Western Climate Initiative, was developed in February 2007. A voluntary agreement between seven U.S. states and four Canadian provinces, it strives to reduce greenhouse gas emissions by 15 percent (as compared with 2005 emissions levels) by the year 2020.

In addition, countries have long suffered from the production decisions of their neighbours. During the second half of the 20th century, several lakes in eastern Canada became more acidic from acid precipitation resulting from sulfur dioxide emissions produced by American industry. In developing countries one of the largest ongoing issues involves the availability of clean water in the border regions. Air quality can decline during the development of seasonal atmospheric brown clouds that travel over several countries. Economic solutions to those problems (and similar transborder problems) will remain the focus of ongoing research.

*Jennifer L. Brown    The Editors of Encyclopaedia Britannica*