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AI analysed 1,500 policies to cut emissions. These ones worked

Only 63 climate change interventions led to significant reductions in carbon emissions.

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Taxes were particularly effective at reducing emissions associated with electricity generation in high-income countries. Credit: Andrew Aitchison/In pictures via Getty

Researchers used machine learning to analyse roughly 1,500 climate policies and identify those that have dramatically reduced carbon emissions. Their study,

published in *Science* today, found that policies that combine several tools are more effective in slashing emissions than are stand-alone measures¹.

The analysis identified 63 interventions in 35 countries that led to significant reductions in emissions, cutting them by 19% on average. Most reductions were linked to two or more policies. Together, the 63 policies cut emissions by between 0.6 and 1.8 gigatonnes (Gt) of CO₂ equivalent.



What's the best way to tackle climate change? An 'evidence bank' could help scientists find answers

Using the right mix of policies is more important than using a lot of policies, says Annika Stechemesser, a co-

author and researcher at the Potsdam Institute for Climate Impact Research in Germany. For example, the UK's phasing out of coal-fired power stations worked because it was used in tandem with pricing mechanisms, such as a minimum carbon price, while in Norway, banning combustion engine cars was most effective when combined with a price incentive that made electric cars cheaper.

"To my knowledge, it is a first-of-its-kind study providing such a global evaluation," says Jan Minx, an environmental economist with the Mercator Research Institute on Global Commons and Climate Change in Berlin.

Road to reductions

As part of the analysis, Stechemesser and her colleagues used a database of 1,500 climate policies implemented between 1998 and 2022 in 41 countries, including the top three greenhouse gas emitters globally: China, [the United States](#) and [India](#). The policies fell into 48 categories, ranging from emission trading schemes to fossil-fuel subsidy reforms.

"Previous evaluations have typically concentrated on a narrow set of prominent policies in selected countries, overlooking the hundreds of other measures," Stechemesser says.

The authors combined machine learning with a statistical analytical approach to identify large emission reductions in four high-emitting sectors — buildings, electricity, industry and transport. They compared the results with policies in the database to assess which policies and policy combinations led to the biggest emission drops.

“This is a rather clever method,” says Zheng Saina, who has analysed global climate policies at Southeast University in Nanjing, China. The conventional way would have been to review the large number of policies and select the important ones, but that approach is subjective and cumbersome, she adds. “The authors instead used machine learning to detect major emissions changes. It is more objective.”

Right mix

The results showed that certain policy combinations worked better in specific sectors and economies. In terms of reducing emissions associated with electricity generation, for instance, pricing interventions such as energy taxes were particularly effective in high-income countries, but less so in lower-and-middle income countries.

In the building sector, policy mixes that included phased out and banned emissions-generating activities more

than doubled the reductions resulting from implementing those policies individually.

Taxation was the only policy that achieved nearly equal or larger emission reductions as a stand-alone policy, as opposed to a policy mix, in all four sectors.

Minx says the study's AI-enhanced approach allowed the researchers, for the first time, to evaluate the effectiveness of a large number of climate policies from a global set of emission inventories covering different countries and sectors.

For other researchers, the paper is alarming. "This study provides a warning to countries around the world that their climate policies have had very limited effects so far," says Xu Chi, an ecologist at Nanjing University. "Existing policies will need to be re-evaluated, and changes will need to be made," Xu adds.

The [world's annual emissions](#) are projected to be 15 Gt of CO₂ equivalents higher by 2030 than would be required to keep global warming to less than 2 °C above pre-industrial levels, according to the United Nations.

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References

- Stechemesser, A. *et al.* *Science* **385**, 884–891 (2024).

