Copenhagen Consensus on Climate: Findings of the Expert Panel

The goal of Copenhagen Consensus on Climate was to evaluate and rank feasible ways to reduce adverse consequences from global warming.

Individual proposals that would achieve this were examined under the eight solution headings of: Climate Engineering, Carbon Cuts, Forestry, Black Carbon Cuts, Methane Cuts, Adaptation, Energy Technology, Technology Transfers.

A panel of economic experts, comprising five of the world's most distinguished economists, was invited to consider these proposals and identify the proposals where investments would be most effective. The members are:

- **Jagdish Bhagwati**, Columbia University
- **Finn Kydland**, University of California, Santa Barbara (Nobel Laureate)
- **Thomas Schelling**, University of Maryland (Nobel Laureate)
- **Vernon Smith**, Chapman University (Nobel Laureate)
- **Nancy Stokey**, University of Chicago

The panel was asked to answer the question:

> **If the global community wants to spend up to $250 billion per year over the next 10 years to diminish the adverse effects of climate changes, and to do the most good for the world, which solutions would yield the greatest net benefits?**

The sum of up to $250 billion per year was chosen by the Center because it is in the order of magnitude of spending that world leaders could commit to in the Copenhagen COP-15 negotiations, and is consistent with the relevant economic literature on the expected costs of dealing with global warming.

The basis for the Expert Panel's discussions and ranking were the 21 Analysis and Perspective Papers: new research commissioned from acknowledged authorities in each policy area.

The Analysis Papers review the existing frontier academic literature and present the economic costs and benefits of one or more relevant policy responses to global warming, as well as outlining the strengths and weaknesses in the applied methodology.

To ensure complete information on each category of solutions, all Analysis Papers are balanced by at least one Perspective Paper, providing a critique of the assumptions and calculations used in the Analysis Paper.

During a roundtable meeting at Georgetown University in Washington, DC, the Expert Panel appraised the research in great depth, and engaged with the Analysis Paper and Perspective Paper authors, whose names are overleaf.

Based on this work, the panel ranked the proposals, in descending order of desirability, as follows:

The Ranking

RATING		SOLUTION	CATEGORY
"Very Good"	1	Marine Cloud Whitening Research	Climate Engineering
	2	Energy R&D	Technology
	3	Stratospheric Aerosol Insertion Research	Climate Engineering
	4	Carbon Storage Research	Technology
"Good"	5	Planning for Adaptation	Adaptation
	6	Research into Air Capture	Climate Engineering
"Fair"	7	Technology Transfers	Technology Transfers
	8	Expand and Protect Forests	Forestry
	9	Stoves in Developing Nations	Cut Black Carbon
"Poor"	10	Methane Reduction Portfolio	Cut Methane
	11	Diesel Vehicle Emissions	Cut Black Carbon
	12	$20 OECD Carbon Tax	Cut Carbon
"Very Poor"	13	$0.50 Global CO_2 Tax	Cut Carbon
	14	$3 Global CO_2 Tax	Cut Carbon
	15	$68 Global CO_2 Tax	Cut Carbon

In ordering the proposals, the panel was guided predominantly by consideration of economic costs and benefits. The panel acknowledged the difficulties that cost-benefit analysis must overcome, both in principle and as a practical matter, but agreed that the cost-benefit approach was an indispensable organizing method.

In setting priorities, the panel took account of the strengths and weaknesses of the specific cost-benefit appraisals under review.

For some proposals, the panel found that information was too sparse to allow a judgment to be made. These proposals, some of which may prove after further study to be valuable, were therefore excluded from the ranking.

Each expert assigned his or her own ranking to the proposals. The individual rankings, together with commentaries prepared by each expert, will be published by Cambridge University Press in a book along with all of the new research. The research material has already been placed in the public domain, and is available at www.fixtheclimate.com. The panel's ranking was calculated by taking the median of individual rankings. The panel jointly endorses the median ordering as representing their agreed view.

If one calculates the total cost of the 'Very Good' and 'Good' solutions, the expenditure proposed by the Copenhagen Consensus runs to around $110 billion a year from 2010-2020.

Notes on Solution Categories

Climate Engineering: The Expert Panel highly recommends research into climate engineering strategies. Of the strategies that the Expert Panel considered, solar radiation management methods – especially marine cloud whitening – appear to show the greatest promise. The Expert Panel notes that, compared with other solution categories, geo-engineering reduces the risk of 'pork barrel politics' and lowers transaction costs. In the case of a low-probability, high-impact situation, climate engineering could play a crucial role because of its speed. The Expert Panel notes that a short-term focus on research into climate engineering would be beneficial in establishing the limitations and risks of this technology, and the identification of these should happen sooner rather than later. They find that research into air capture would be useful as air capture appears to have potential as a backstop technology.

Technology: The Expert Panel believes that increased research into energy technology is vital to ensure a move away from reliance on fossil fuels. There is a significant energy technology challenge to stabilizing climate, demonstrated by the lack of readiness of current carbon-emission free energy technologies. The Expert Panel finds that there is a compelling case for greater research into technologies including (among others) storage for energy, batteries, nuclear energy and nuclear reprocessing technology, fusion, second generation biofuels, wave energy, geothermal energy, and technology that increases the conversion rate of fossil fuels. They also find that research into carbon capture and sequestration (carbon storage) is very important because this technology has considerable potential as a bridging technology to a zero carbon future.

Adaptation: Whatever other policy options are selected, adaptation will be needed because it is unlikely that all of the impacts of climate change will be avoided. Adaptation is unavoidable and may serve multiple purposes, including helping developing countries in terms of development, and non-climate related disaster readiness. The Expert Panel finds that it is very important to ensure that planning occurs for future adaptation, focusing particularly on anticipatory (or preparatory) adaptation. In the long-term, a combination of proactive and reactive adaptation is an effective means of reducing the damage from climate change. Because of the distribution of expected climate change effects, most adaptation expenditure needs to be beneficial to developing nations.

Technology Transfers: Technology Transfers are a promising approach for dealing with climate change, because international cooperation on both greenhouse gas mitigation and adaptation must involve transfers of technologies and dissemination of knowledge. While developed countries are beginning to constrain growth in carbon emissions, emissions from developing countries are growing, showing a requirement to ensure that knowledge on mitigation and adaptation strategies and implementation is shared.

Forestry: Ecosystems store approximately 1 trillion tons of CO2 in the biomass of living trees and plants. Methods to increase this carbon efficiently in order to reduce the future damages of climate change include

afforestation (planting old agricultural land in trees), reduced deforestation, and forest management. The Expert Panel agrees with the Analysis and Perspective Paper findings that these solutions would have benefits both in terms of reducing global warming and in terms of increasing biodiversity. The forestry solution was not given a higher ranking because this would be a relatively costly way of cutting carbon, and there are regulatory challenges relating to implementation and leakage to be overcome.

Black Carbon Mitigation: The Expert Panel heard that mitigating black carbon emissions would be beneficial for health improvements in developing nations as well as in climate change outcomes. However, there is a broad difference of scientific opinion regarding the role of black carbon in global warming, and the research into this field is relatively young. The non-climate, health benefits vastly outweigh the climate benefits, making it more of a health policy proposal. When looking at the proposal to reduce household black carbon emissions in the developing world, the Expert Panel found it difficult to locate large-scale, successful examples of programs, and the evidence suggests that there are acceptance and transition issues. The costs of implementing vehicular technology solutions is high comparative to the benefits. For these reasons, the Expert Panel gives solutions considered under the topic of Black Carbon Mitigation a lower ranking.

Methane Mitigation: Methane is a major anthropogenic greenhouse gas, second only to carbon dioxide in its impact on climate change, but is challenging to regulate and control. It has many non-point sources that can be small, geographically dispersed, and not related to energy sectors. The most important single sector emitting methane is livestock production, and the technical measures available to reduce emissions from livestock are small. The Expert Panel observes that the short-term nature of methane means that its mitigation is less relevant than other proposals to longer-run climate damage. The best options to regulate methane in livestock and agriculture would face almost insurmountable obstacles in practice. For these reasons, the solution considered under the category of Methane Mitigation was given a lower ranking. The Expert Panel notes that commercial-scale extraction of methane clathrate would pose a serious issue, as it could lead to large leakage.

Carbon Mitigation: The Expert Panel finds that, while a well-designed, gradual policy of carbon cuts could substantially reduce emissions at a low cost, poorly designed or overly ambitious policies could be orders of magnitude more expensive. Very stringent targets may be costly or even infeasible. The Expert Panel finds that high levels of carbon tax, in the short-term, would be a poor response to climate change. They note that the geographical spread of global warming damage – and its greater damage to developing nations – means that estimates of GDP loss should be treated with some caution, and that the low probability of high impact results from global warming should be taken into account when evaluating carbon mitigation.

In addition to the three global tax options in the Analysis Paper by Professor Richard SJ Tol, the Expert Panel finds it relevant to scrutinize the impact of a tax on developed nations only. Therefore, they have considered a scenario from the Yohe and Tol paper from Copenhagen Consensus 2008, proposing a CO2 tax on OECD nations of $20. The Expert Panel has looked at carbon taxes, which are likely to be more efficient than a cap-and-trade scheme. The Panel notes that many politicians are opting for the latter, and that the use of such an emissions trading scheme is likely to further diminish the returns of the solutions considered here. They also conclude

that the costs and benefits of regulatory interventions (such as energy efficiency standards) to mitigate carbon deserve future examination.