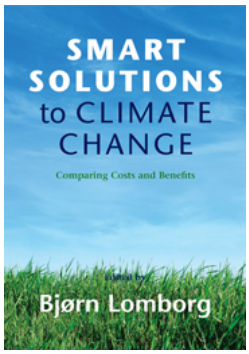
Book Review



Smart Solutions to Climate Change: Comparing Costs and Benefits, edited by Bjørn Lomborg, Cambridge, New York: Cambridge University Press, 2010, 436 pp., $90.00 (hardback), $24.00 (ebook)

Reviewed by Dimitri Zenghelis

In his latest edited book, *Smart Solutions to Climate Change*, the self-styled skeptical environmentalist Bjørn Lomborg might be mistaken for having made an abrupt volte-face in his views. "Climate 'sceptic' Bjørn Lomborg now believes global warming is one of world's greatest threats," blazed the Daily Telegraph; "The dissenting climate change voice who changed his tune," hailed the Guardian. And on first pass, this does appear to be the case: "The risks of unchecked global warming are now widely acknowledged," Lomborg writes. "We have long moved on from any mainstream disagreements about the science of climate change." He adds: "Climate change is undoubtedly one of the chief concerns facing the world today." He ends by asserting that

> *If we care about the environment and about leaving this planet and its inhabitants with the best possible future, we actually have only one option: we all need to start seriously focusing, right now, on the most effective ways to fix global warming.*

But behind the bombastic rhetoric, Lomborg has always agreed that man-made global warming is real. Yet he has always played down the need for emissions reductions, and he continues to do so here. He argues that there is no need to reduce CO_2 emissions to any significant extent in the near future. "It is unfortunate that so many policy makers and campaigners have become fixated on cutting carbon in the near term as the chief response to global warming," he claims. Referring to the judgment of his handpicked Expert Panel of five, he concludes that "drastic carbon cuts would be the poorest way to respond to global warming." Instead, he favors increased spending on green research and development (R&D): "R&D in green energy technologies is really the only viable long-term strategy for reducing fossil-fuel consumption without crippling the world economy."

Although the book contains a diversity of well-informed views from established practitioners (though none are climate scientists), its full value falls short of the sum of its parts. A lack of structure makes it a somewhat incoherent and rather misleading read. The

book has eight chapters, by different authors, each containing complex analysis and reviews of other studies purportedly aimed at establishing the costs and benefits of spending up to US$250 billion annually on 'solutions' to climate change such as climate engineering, carbon dioxide mitigation, carbon sequestration, adaptation, and technology transfers. Each chapter then contains an 'alternative perspective' section with contributions from other commentators. The options are then weighed up by a chosen Expert Panel of five. Lomborg introduces the book and summarizes in a sentence or two the authors' key findings. The chapter topics are far from exhaustive and—perhaps unsurprisingly given the editor's predisposition—only one chapter in eight is devoted to options for CO_2 mitigation.

Flawed Method

From the outset, Lomborg's basic method is flawed. He sets up an arbitrary challenge: "If the global community wants to spend up to, say, $250 billion per year over the next 10 years to diminish the adverse effects of climate change, and to do most good for the world, which solutions would yield the greatest net benefits?" In this way he assumes some notional budget constraint for the sum total of global spending on social and environmental ills, and then uses cost-benefit analysis to rank projects. By doing so, he appeals to the common sense doctrine of getting the "biggest bang for the buck."

But this doctrine constitutes bad economics. First, the projects and outcomes are almost all interrelated. Many of the development challenges Lomborg would prefer to spend money on (fighting AIDS, preventing malaria, and providing water and micronutrients) will be made worse, maybe much worse, by climate change, and the impacts of climate change are made much worse by delaying a response to these challenges. If the projects are interrelated in this way, rather than independent, then it is inappropriate to handle the analysis by assuming separate, mutually exclusive choices. This would be like arguing that it is preferable to build a roof than to build walls or foundations, because the roof is better at keeping out the rain.

Second, Lomborg fails to acknowledge that there are many market failures that can be addressed through action to reduce emissions. These relate to waste, inefficiency, congestion, biodiversity, and the under-supply of innovation that generates freely available knowledge spillovers, as well as the undersupply of infrastructure due to network economies. Such failures cannot be evaluated by means of an arbitrary budget constraint. Third, it is a mistake to use marginal cost benefit analysis to try and project the impact of large irreversible changes both to the climate and to technological innovation in the energy sector. Such large and non-marginal issues require a more sophisticated analytical approach taking full account of projected risks.

Finally, it is worth noting that for all his claims to favor spending on alternative development options, Lomborg spends very little energy actually championing these causes when compared with the time he spends decrying the value of emissions reductions. Readers can judge for themselves, but this might suggest that fairness and effectiveness are not his overwhelming concerns.

Lomborg Assumes Away Risk

Existing peer-reviewed climate science is clear about the risks from unchecked emissions growth. As summarized in the IPCC fourth assessment report, the business as usual and unabated emissions scenarios raise the risk of catastrophic, irreversible climate events like widespread floods, droughts, storms, heat waves, famine, disease, and devastating coastal inundation, which could render billions of people poorer than they are today. The physical and human geography of the planet likely would be radically transformed in little over 100 years. By contrast, Lomborg repeatedly argues that the risks from climate change are small. He argues that any warming we see, and additionally the damages associated with any warming we see, will likely be at the lower end of the model predictions.

In order to estimate the value of mitigation, Lomborg uses Richard Tol's model of climate impacts. It is worth noting that Richard Tol is an economist who, much like Lomborg, consistently downplays the case for urgent action on mitigation, preferring instead to champion the cause of climate adaptation. Tol's model systematically down-weighs future impacts and overstates the lack of affordable options to bring emissions levels down. It is also a deterministic model that does not deal with the central question of uncertainty. His model misses key elements of the story: where he tends to argue for greater action, for example, he does not include tipping points in the climate system, so that projected damages rise very slowly at high temperatures. Tol also calibrates his analyses on the basis of out-of-date scientific assumptions, in many cases using pre-2000 results.[1]

Lomborg uses Richard Tol's modeling assumption that unabated climate change can only ever have a marginal impact on GDP, affecting richer generations in the far future. Tol projects a mere 2% loss in GDP for a 5°C temperature increase—something that would rewrite the world and lead to mass migration and conflict. Indeed Tol's model projects net benefits to the world from warming until the world is almost 3°C warmer.[2] To reduce emissions, Tol declares that "the only scenario worth funding" is to apply a carbon tax of about \$2/tC (\$0.55/tCO_2). This would add only a small fraction of a percentage to energy bills, but alone would not prevent the level of CO_2 equivalent (CO_2e) concentrations in the

[1] A cursory glance at his bibliography will affirm that he rarely uses, or refers to, more recent studies that are based on the latest scientific assessment of the risks. Particular recent examples include model studies by Ackerman, Sokolov, Stern, Hepburn, Weyant, Watkiss and Hope.

[2] Temperature changes are all expressed relative to pre-industrial times.

atmosphere from rising to over 850 parts per millions (ppm) by the end of the century, compared with around 440ppm CO_2 e today. This would mean significant probabilities of warming by 5°C within a century or so compared with today, a temperature the world has not seen since the Eocene period some 30–50 million years ago.[3]

Just as unsettling is the implicit assumption that the impacts of climate change are known with certainty and can be used to design with precision the optimal policy mix. This is unrealistic and foolhardy. The scientific consensus agrees that there are low-probability risks of devastating and irreversible impacts associated with continued increases in GHG concentrations. Concentrations of 850ppm CO_2e could lead to far higher global temperature increases, maybe a one-in-a-hundred chance of 8°C or 9°C.[4] And scientists agree that the impact of any temperature increase on the global climate may be larger than the central expectation, perhaps triggering run-away thresholds like the release of methane from the tundra or the melting of the Greenland and West Antarctic ice sheets. Of course, the impacts may be smaller than the central expectation. But as with the risk of our homes being burgled or burned down, it is the downside uncertainty that motivates us to take out insurance even though we know the insurance company will make money off us. Assuming away climate uncertainty eliminates much of the case for action, which is about paying an acceptable premium to insure against dangerous consequences.

This strategy is irrational because such denial would require great confidence both that the scientific findings are wrong and that the corresponding risks are small. To understand this, assume that the scientific findings are wrong but we act as if they were right. This might lead us to excessive investment in developing low-carbon technologies and protecting forests; but these actions nevertheless have substantial other benefits in energy security, energy efficiency, biodiversity, and so on. Now assume that the scientific evidence is right but we act as if it were wrong. This would lead us to concentrations of carbon dioxide carrying immense and potentially irrevocable risks. And yet Lomborg insists that "alarmism on the part of environmentalists and climate scientists prevents a rational discussion." On the contrary, with the science driving the case for action, dealing rationally with climate change means adopting a comprehensive and robust risk-management approach.

Systematic Undervaluation of the Future

Lomborg argues that future generations will be so wealthy that very major impacts of climate change, such as global sea level rises of a few meters, would be more affordable than cutting greenhouse gas (GHG) emissions to stabilize levels in the atmosphere. There

[3] Based on the conclusions of IPCC (2007), a GHG level of 850ppm CO2e would mean a 50:50 chance of a 5C warming (at stabilisation).

[4] Based on IPCC (2007), and across a number of climate sensitivity distributions.

is some truth to this. It makes no sense to burden poorer generations today with costs that can more easily be born by richer generations in the future. But by ignoring risk and taking global averages, this rules out the possibility that some sections of the population in vulnerable parts of the world may be poorer—perhaps much poorer—in the future because of climate change. And for these sections of the population, the loss of a few dollars in daily income will have a substantial welfare impact, often life-threatening. If climate change involves huge risks, then this changes the assumptions about future income levels and thus assumptions about the discount rate. Because outlier impacts are not adequately represented in Tol's deterministic cost benefit framework, the risk-adjusted costs of inaction on emissions are again unambiguously under-stated.[5]

Tol uses an average discount rate of 5% over the next century, without making it clear how he arrives at that figure. At 5% continuous discounting, a person's consumption in the middle of the next century would be valued at around 1/150 of a person's consumption today, thus favoring policies that benefit current generations today at the expense of those in the future. Indeed impacts beyond 2100, where the most threatening consequences of climate change are expected to arise, are dismissed altogether. According to Ackerman, by using a 5% discount rate, Tol makes it appropriate to *subsidize* those who emit carbon, because "they are accelerating the arrival of the gloriously hotter mid-century years."[6]

It seems hard to argue for discriminating against future generations purely on the basis of birthdates—a process known as pure time discounting. This is distinct from discounting because of income differences, or discounting because of the risk of future extinction, both of which can be expressed quantitatively as in The Stern Review. Pure time discounting is rooted in the economist's desire to reflect people's preferences, as people are impatient in many of the things that they do. But climate change is such a long-term social problem that it is inconsistent to use personal telescopic preferences, as reflected in market interest rates as the basis to determine policy. Why should we objectively treat the well-being of current generations on an equal basis, but apply a different treatment to the well-being of generations born next year, or the year after? Doing so guarantees that through time we will be shown to have made the 'wrong' decision. The fact is we don't, which is why so many of us think treating the atmosphere like an open sewer for future generations to cope with or suffer from is morally inadequate.

[5] See Dietz (2010) "High impact, low probability? An empirical analysis of risk in the economics of climate change," Climate Change; and Dietz et al (2007) "Right for the Right Reasons: A Final Rejoinder on the Stern Review," *World Economics*.

[6] See Ackerman and Stanton (2010) "The social cost of carbon," *Real-World Economics Review,* no. 53.

No Assessment of the Costs of Delay

Lomborg urges us not to be rash. We can't make proper decisions and prioritize our goals if we think we have a gun at our heads.[7] This is very true, but it is irrational to ignore the obvious fact that early emissions cuts would be far cheaper if we manage the transition by working with the investment cycle and prevent the lock-in of high carbon infrastructure, than if we rush to remove carbon-intensive infrastructure (or carbon from the air) later, calling forth expensive technologies that have not had time to mature. Early action does not mean rash action given the balance of risks. Every year of delay increases the costs of meeting a temperature target while opening up additional climate risks.

Lomborg uses Tol's findings to show that meeting a two-degree pathway would require a "staggering" 12.9% reduction in world gross domestic product.[8] That is indeed staggering, but thankfully it does not represent the economic community's main findings. A variety of economic assessments of the impact of a global effort to avoid dangerous climate change put the impact on global GDP at around 2% by mid-century over a period in which, by comparison, the world economy will have approximately tripled in size.[9,10] There are in fact a lot of options for reducing carbon emissions and making money in the process, both by increasing efficiency and reducing waste and by developing innovative processes and technologies that boost productivity.[11] Economic models are just now coping with market failure and waste, as well as with learning and experience associated with new innovation. A few even include knowledge spillovers. But all struggle to model the 'animal spirits' and innovative dynamism usually associated with non-marginal technological revolutions. Thankfully, entrepreneurs understand the transformative value of such processes even where economists don't.[12]

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[7] See http://news.bbc.co.uk/1/hi/sci/tech/3486894.stm

[8] It would require a tax of $100 per tonne of CO_2 worldwide, from 2010 rising rapidly with time.

[9] The reader is pointed in the direction of the ADAM project (http://www.adamproject.eu/) and the RECIPE report on The Economics of Decarbonization (each uses more than one model) as well as IEA, IPCC, McKinsey, OECD, and Stern Review findings.

[10] Unlike Tol, who imposes a strict limit on emissions staying below 450ppm CO_2e, more measured studies recognise that we will overshoot 450ppm CO_2e in concentrations, keeping them below 500ppm CO_2e and then gradually bringing them down to 450ppm CO_2e or less in order to have a good chance of keeping below 2°C. Tol also ignores the fact that the global cooling impact of atmospheric sulphate aerosols means that GHG concentrations can remain higher for longer, consistent with meeting a 2°C goal at lower cost.

[11] McKinsey estimate 15-20 Gt of CO_2 annually worldwide may be avoided at an average cost of less than zero by 2030: https://www.mckinseyquarterly.com/A_cost_curve_for_greenhouse_gas_reduction_1911

[12] Some models even give positive GDP gains because they assume that economies are not functioning optimally and that climate change mitigation policies can help to reduce imperfections in the economy. The presence of numerous market failures in energy technologies mean this is not as unrealistic as it sounds.

Tol also notes that "the analysis presented here also omits suboptimal policy design. Carbon price differentiation and direct regulation may well increase abatement costs by a substantial margin." This is surely correct. Uncoordinated delayed policy will only make things more costly, but that is precisely why interventions like Lomborg's, which impede coordinated action, are so dangerous.

Why Kyoto Was a Start

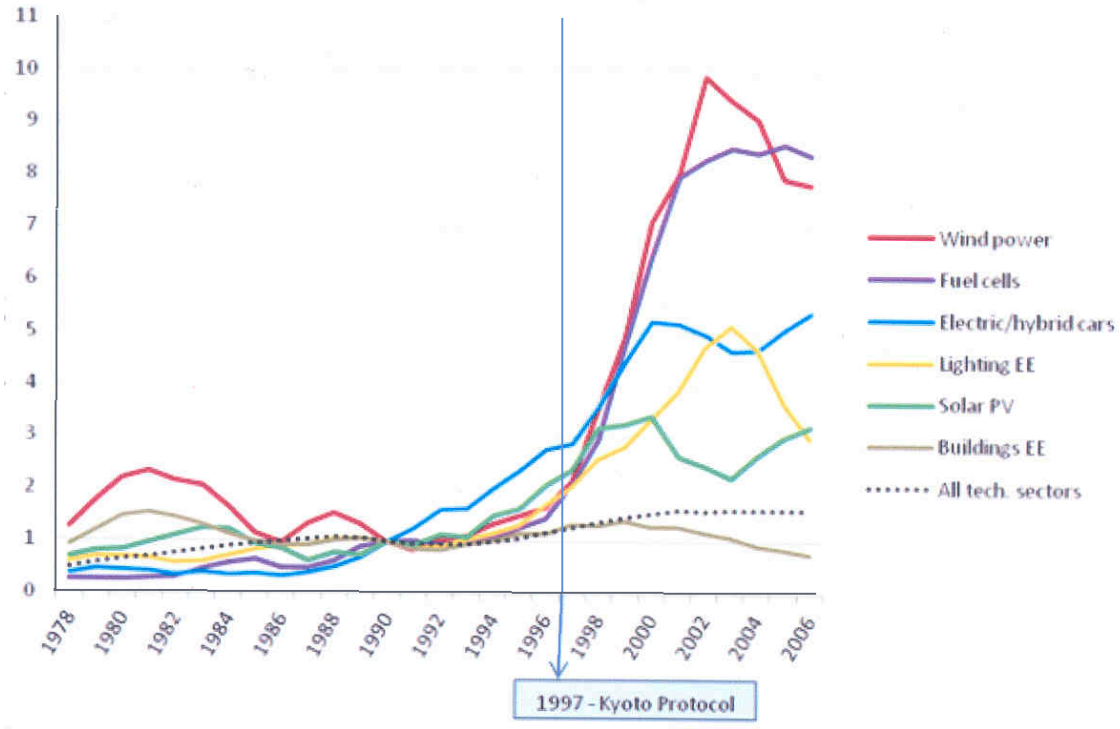
Lomborg argues that the 'Kyoto approach' to global warming has failed and recommends that we seek other ways of solving global warming:

> *Reading the research in this volume—written by some of the top climate economists working in this field today—it is easier to understand why a single-minded focus on drastic carbon emission reductions has failed to work.*

Kyoto was doubtless imperfect and insufficient. But by sending a clear policy signal to the private sector, the 1997 Kyoto protocol coincided with a marked up-turn in innovation in key green technologies such as wind, solar PV, fuel cells and electric vehicles (Figure 1).

Figure 1: Innovation in Climate Change Mitigation Technologies

Patenting activity in Annex-I countries
(3-year moving average, indexed on 1990=1.0)



Source: OECD 2010. OECD Project on Environmental Policy and Technological Innovation.

Focus on Technology Not Enough

On the positive side, Lomborg now calls for an investment of $100 billion per year on research and development for low-carbon technologies, instead of the $25 billion he was advocating 18 months ago. This is welcome, but it is only one element of the combination of policies needed to promote the development of a global low-carbon energy system. Without a clear price signal to stimulate investment and behavioral change, this is unlikely to make for ambitious cuts. He says that "trying to force carbon cuts instead of investing first in research puts the cart before the horse." In fact, the reverse is true. Funding R&D without using all the tools in the policy-maker's tool-box to address specific market failures and secure a long-term credible market could be a spectacular waste of resources, leading to policy recommendations that are inadequate, inefficient and surprisingly statist.[13]

A more robust approach to managing the risks of climate change would be not only to invest in R&D, but also to use a carbon tax (or cap-and-trade) to discourage greenhouse gas emissions in the short run. Pricing carbon creates a clear market signal to induce behavioral change and innovation and provide a valuable new asset for businesses and investors to accumulate. But to encourage enough emissions cuts in the next few years to keep greenhouse gases at low enough atmospheric concentrations, a carbon price considerably higher than Tol's $2/tC is required.

Lomborg remarks that "although carbon taxes and a 'cap-and-trade' scheme should, in theory, have very similar outcomes, the latter produces a much higher opportunity for 'pork-barrel politics' and waste." It is certainly true that the issuance of free emissions permits to hard-pressed industries opens up the scope for special pleading. The design of the EU emissions trading scheme has continued to improve in order to limit such incentives. Yet only the most naïve analyst would assume that just because a pure tax does not contain such mechanisms, no additional mechanisms would be created to compensate the losers. Such supplementary mechanisms are inevitable and would be equally susceptible to lobbying and waste.

An Exaggerated Role for Geoengineering

Lomborg makes much of the potential benefits of geoengineering: strategies such as space mirrors or aerosol injection to reflect sunlight and offset the effects of global warming. In an idea that emerged from the Copenhagen Consensus, he recommends that a fleet of 1900 robotic ships patrol the ocean, releasing particulates and ocean spray to reflect the sun's

[13] See Bowen "Fighting Climate Change: the Case for Using All the Tools in the Tool-box" Grantham Research Institute, LSE, forthcoming.

rays. With atmospheric concentrations certain to overshoot 450ppm CO_2e, low-intensity geoengineering is indeed an option that needs to be investigated as a means to manage the transition to decarbonization. However, it is not without risks and certainly does not provide a substitute to active mitigation.

As White House science advisor John Holdren asserted in 2009: "The 'geo-engineering' approaches considered so far appear to be afflicted with some combination of high costs, low leverage, and a high likelihood of serious side effects." With our incomplete knowledge of the workings of the non-linear climate system, many scientists argue that stratospheric geoengineering cannot be tested without full-scale implementation over decades. Once again Lomborg irrationally underplays risks and uncertainties. Moreover, most geoengineering 'solutions' do nothing to stop the underlying rise in GHGs or the consequences of ocean acidification, which some studies suggest will be a major problem in its own right.[14] Geoengineering is important, but relying on it alone is a bit like relying on methadone to cure the addiction of a heroin addict.

Conclusion

Whether or not Bjorn Lomborg has changed his mind is a moot point. The more important fact is that Lomborg continues to grab headlines, fill more newspaper column inches, and capture more TV airtime than almost any climate scientist. Until this changes, the chances of a successful, collaborative resolution to this urgent global issue, guided by a common understanding, remains slim. As Howard Friel recently wrote in The Guardian:

> *If Lomborg were really looking for smart solutions, he would push for an end to perpetual and brutal war (over climate action), which diverts scarce resources from nearly everything that Lomborg legitimately says needs more money.*

To offer smart solutions, Lomborg would need to commit to the following changes: stop contradicting the climate scientists by downplaying the risks from climate change; take a more balanced view of the findings of economists, engineers and technologists, who highlight significant opportunities for cost-effective emissions reductions; and focus on mitigation, in order to eliminate risks, rather than adaptation and geoengineering, which amount to the policy equivalent of mopping up water with the tap left running. Such changes would indeed mark a u-turn and bring Lomborg into line with the leading practitioners in the field. But they do not feature in this book. Instead, Lomborg stays true to his irrational course. He continues to advocate almost anything other than making carbon emissions more expensive—the one tool most economists feel is likely to lead to

[14] These policies would need to be supplemented by additional measures such as air-capture or liming the oceans.

cost-effective behavioral change and incentivize innovation in the development of new markets. Consequently, it remains wise to be wary of his pronouncements, no matter how much publicity they attract.

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References

Ackerman, Frank and Elizabeth A. Stanton. 2010. "The social cost of carbon." *Real-World Economics Review* No. 53, 26 June: 129–143. Available from http://www.paecon.net/PAEReview/issue53/AckermanStanton53.pdf

ADAM. 2011. Adaptation and Mitigation Strategies: Supporting European climate policy. Available from http://www.adamproject.eu/

Bowen, Alex. "Fighting Climate Change: the Case for Using All the Tools in the Tool-box." Grantham Research Institute. The London School of Economics and Political Science (forthcoming).

Dietz, Simon. Last revised 2010. "High impact, low probability? A brief empirical analysis of risk in the economics of climate change." Centre for Climate Change Economics and Policy, working paper No. 10. Grantham Research Institute on Climate Change and the Environment, working paper No. 9 2009.

Dietz, Simon, Dennis Anderson, Nicholas Stern, Chris Taylor, and Dimitri Zenghelis. 2007. "Right for the Right Reasons: A Final Rejoinder on the Stern Review." *World Economics* 8 (2): 229–258. Available from http://www.world-economics-journal.com/Contents/ArticleOverview.aspx?ID=292

Edenhofer, Ottmar, Carlo Carraro, Jean-Charles Hourcade, and Karsten Neuhoff et al. 2009. "RECIPE - The Economics of Decarbonization." Available from http://www.economicsclimatechange.com/2009/11/recipe-economics-of-decarbonization.html

Enkvist, Per-Anders, Tomas Nauclér, and Jerker Rosander. 2007. A Cost Curve for Greenhouse Gas Reduction. *McKinsey Quarterly.* Available from https://www.mckinseyquarterly.com/A_cost_curve_for_greenhouse_gas_reduction_1911

IPCC. 2007. *Climate Change 2007: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). UK and NY: Cambridge University Press. Available from http://www.cambridge.org/features/earth_environmental/climatechange/wg2.htm

Kinver, Mark. 2004. "Eco-myths are a gun to the head." BBC News Online. 27 February. Available from http://news.bbc.co.uk/1/hi/sci/tech/3486894.stm

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