IIASA Policy Brief

#14 ▪ November 2016

Between 1.5°C and 2°C — analyzing the global warming targets

Two temperatures feature prominently in the Paris Climate Agreement: 1.5°C and 2°C. New studies from IIASA reveal substantially different climate impacts under these two targets and provide a clearer understanding of the challenges and benefits of aiming low on global warming goals.

Summary

The Paris Agreement of November 2015 commits signatories to "holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels." The agreement also states that in order to achieve this goal, greenhouse gas emissions need to peak as soon as possible then decline rapidly, becoming net-zero in the second half of the century by achieving a balance between emissions and removals.

Effectively, this leaves the world committing to at least a stringent 2°C goal but also continually shooting for an even more stringent 1.5°C goal. Many countries, including those most vulnerable to climate change, consider the lower level a much safer bet than the higher one. In this policy brief we discuss the substantial benefits of hitting the lower goal and the need to set near-term benchmarks on emissions in order to achieve it. Tapping into recent research, we also explore the differences and characteristics of the pathways to both goals while remaining focused on 1.5°C as the lowest risk option.

- The difference a half degree makes. Limiting global temperature rise to 1.5°C by 2100 is technically achievable and will mean fewer and shorter heat waves in the tropics, greater crop yields, and a reduction in sea level rises compared to a 2°C world. The risks of just half a degree higher warming are clarified by new studies providing essential information on the likely different outcomes under the two warming levels.

- Where are we now? Despite recent efforts, global greenhouse gas emissions are still increasing and are projected to continue to do so until 2030 under the current pledges. Although there have been some positive signs showing stalling global emissions in recent years, it is still too early to say if this will become a long-term trend. This lack of progress means carbon budgets are burning up quickly, placing a tighter constraint on future emissions.

- What are the key elements to achieving the 1.5°C goal? A rapid, near-term de-carbonization of energy supply; greater mitigation efforts to reduce energy demand; and acceptance that mitigation costs will be greater in the next two decades than for a 2°C goal. Energy efficiency improvements will also be crucial and comprehensive emissions reductions must be achieved in the coming decade.

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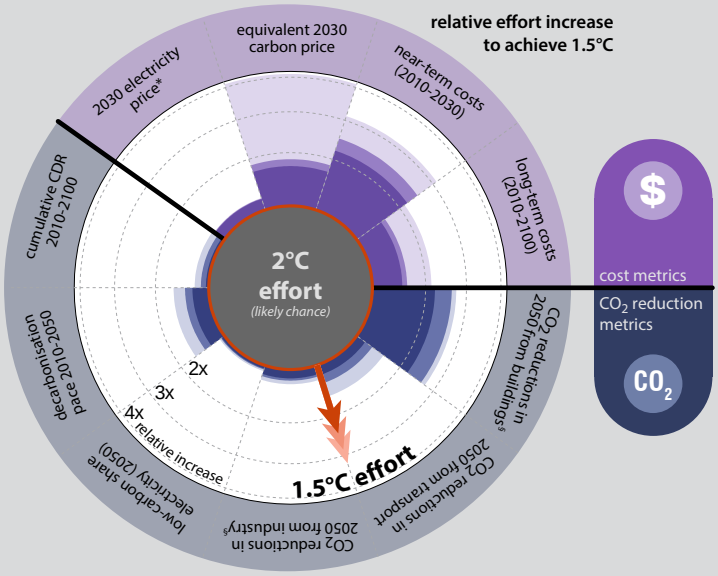

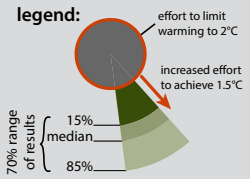

Figure 1
Relative increase in mitigation efforts when moving from a 2°C to a 1.5°C pathway. For example, near-term costs are significantly higher, while cumulative carbon dioxide removal (CDR) over the 21st century is quite similar.

Source: Rogelj et al. (2015a)

Introduction

1.5°C versus 2°C was a major debate leading up to the Paris Agreement. The agreement then included these two temperatures as boundaries for global warming limits: warming is to be kept well below 2°C, with continuous efforts to limit it to 1.5°C, in itself "well below" 2°C. Knowing the goal, countries are then able to do the quantitative work of setting their own carbon budgets and policies that will lead to the globally agreed outcome at the end of the century. The major penalties to be paid in terms of climate change, sustainability and social impact if sights are not set on the lower bar are now becoming clearer through IIASA research. That means emissions reductions being implemented early. In other words, there will be long-term consequences from decisions we make now and in the next few years.

What are some of those consequences and who will be affected? In an assessment of the key features of climate change at 1.5°C and 2°C warming IIASA research finds substantial differences. The 0.5°C increase means some areas of the globe will be dealing with a completely new climate regime. This is a much more challenging scenario than "events at the upper limit of present-day natural variability"— the description of climate change impact at a 1.5°C warming level. The negative effects will be greatest in tropical areas. In a 2°C warming scenario virtually all tropical coral reefs are projected to be at risk of severe degradation due to temperature-induced bleaching from 2050 onwards. The 1.5°C projection, although still severe, provides a better outlook. 90% will be at risk in 2050 but that percentage will decline to 70% by 2100.

Similarly, analysis of precipitation projections reveals both dry and wet times ahead for many. One example is the Mediterranean region where the reduction in median water availability will nearly double under the 2°C scenario and the duration of dry spells will increase by 11% compared to 7% with 1.5°C warming.

There are many more examples which allow us to understand the difference a half degree makes. For example, in a 1.5°C scenario, the rate of sea-level rise in 2100 would be reduced by about 30% compared to a 2°C scenario.

Windows are closing— can we keep them open?

In an article published in *Nature* in June 2016 IIASA scientists wrote: "About two thirds of the available budget for keeping warming to below 2°C have already been emitted." Given that emissions are still rising and that to limit warming to 1.5°C at the end of century they are meant to peak by 2020 at the latest before they begin to fall rapidly, the scientists conclude that this is a window nearly closed. Furthermore: "The window for limiting warming to below 1.5°C with high probability and *without temporarily exceeding that level* already seems to have closed." They describe the need for a decline in global emissions to begin as "urgent."

Under the Paris Agreement a stocktaking process allows signatories to assess progress. This is a five year cycle of countries putting forward their Nationally Determined Contributions (NDCs) until 2030 and then meeting to tally up emissions projections and implied carbon budgets, for example. During these meetings they will assess whether the world is on track to limit global warming to well below 2°C degrees or to 1.5°C or whether it will actually overshoot the target. This stocktaking is the process that will have to ensure that emissions reductions are sustained over time.

In summary, there is a near-term plan to ensure that emissions peak and then begin declining, and a mid-term plan to achieve global net-zero emissions with anthropogenic greenhouse gas emissions, mainly CO_2, matching the anthropogenic removals at some point during the second half of the century.

However, according to a new IIASA analysis of country pledges under the Paris Agreement—assuming emissions reduction efforts continue at the same level after 2030—median global temperature increases will reach 2.6°C to 3.1°C in 2100. Given our understanding of the climate response to emissions, global warming will almost certainly go beyond 1.5°C and 2°C before the end of the century unless there is a commitment to greater emissions reductions in the near term.

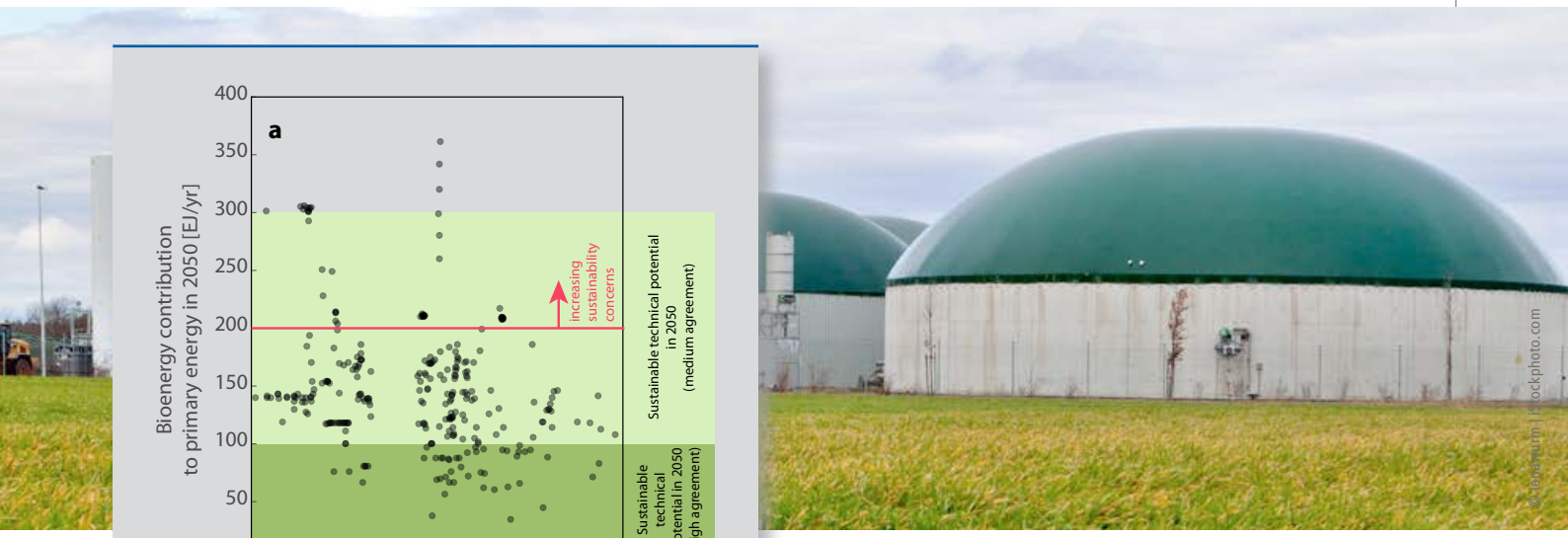

Figure 2
The amount of bioenergy assumed to be produced under 1.5°C or 2°C warming can be very similar.

Source: Schleussner et al. (2016b)

The IIASA paper outlines how, in the absence of greater emissions reductions in the near term, achieving the Paris Agreement target will increasingly rely on negative emissions; that is, CO_2 removal technologies such as carbon capture and storage combined with bio-energy. It also makes clear that the greater we allow the overshoot in temperature rises to become, the greater will be the reliance on technologies that are yet to be tested and which are likely to have deep social and environmental impacts.

Which pathway?

There is no easy path to the 1.5°C goal but some paths appear less difficult. Unfortunately they all begin yesterday, now, or tomorrow. The following points can be drawn from IIASA research:

- Country emission commitments (current NDCs) need immediate substantial strengthening and renewed efforts before 2030 to minimize global warming overshoot.
- Much faster improvements in energy efficiency will make an important contribution.
- Significant amounts of CO_2 will need to be removed from the atmosphere.
- Further ambitious reductions in emissions will be required beyond 2030.

Trade-offs and technology

IIASA research shows a trade-off between near-term action on emission reductions, and reliance on technologies to remove CO_2 from the atmosphere (i.e. negative emissions) in the long term. These technologies exist today but it is not known whether they will work when they are applied on a large scale. For example, large scale bioenergy may lead to competition for land and this could disrupt agricultural output. However, we can reduce the chances that we will need to rely on negative emission technologies by reducing emissions more in the near term.

So how, given the sustainability problems with negative emissions technology, can we still aim to hit the 1.5°C target? Delving further into the IIASA analysis we see that to limit warming to 1.5°C by the end of the century there are no scenarios that allow emissions to peak later than 2020. After 2020 emissions must start declining. On the other hand, studies investigating what occurs when emissions only peak in 2030 find that warming can stay below 2°C, but only with low likelihood, and through the use of carbon capture and storage along with large scale bioenergy. The possibility of protecting sustainability by only using part of bioenergy's potential would be strongly reduced.

What emerges from this analysis is a convergence of near-term emissions reductions and negative emissions that would leave two windows open:

1. To limit warming to 1.5°C by the end of the century—first overshooting and then with negative emissions coming back to target.
2. Leaving open the possibility of staying below 2°C with a high likelihood and without relying on large-scale negative emissions.

But for this to be achieved, near-term action is essential. If we wait until 2030, without those large-scale negative emissions, even the 2°C target will be missed and we will not limit warming to "well below 2 degrees."

What about the sustainability issues—can they be dismissed? Without doubt this is an important factor but the research shows that those issues will be there under all scenarios. Figure 2 shows that the amount of bioenergy assumed to be produced under 1.5°C or 2°C warming is basically the same. Bioenergy is not exclusively an issue of low emission scenarios. Even in a 2.5°C world, the same amount of bioenergy could be used and the land conflict arising from bioenergy remains as an issue to be resolved whichever path is taken.

IIASA Policy Briefs present the latest research for policymakers from IIASA—an international, interdisciplinary research institute with National Member Organizations (NMOs) in 24 countries in Africa, the Americas, Asia, Europe, and Oceania. The views expressed herein are those of the researchers and not necessarily those of IIASA or its NMOs.

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Conclusions

This policy brief has mainly dealt with near-term and mid-term policy issues and not with those for the second half of the century. However, there are important issues to consider because decisions taken now will affect the aim to have net-zero emissions after 2050 and will determine the extent to which we have to rely on large-scale negative emissions with all of the potential consequences. Knowing that the emission reduction commitments made in Paris for the 2020-2030 period will not lead to either a 1.5°C or even 2°C scenario, IIASA research stresses the following points:

- **1.5 is achievable:** The differences between aiming for 1.5°C compared to 2°C are significant in terms of outcome but not significantly different in terms of input (Figure 1).
- **Reduce emissions now:** To reduce the chances of reliance on large-scale bio-energy and carbon capture and storage, reduce emissions as much as possible as soon as possible—in fact the downturn should have started already.
- **Net zero by 2050:** While implementing near-term emission reductions, it is also necessary to focus on the global vision of net-zero CO_2 emissions by 2050.

References and useful resources

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CD-links

An important question for policymakers is how individual countries meet the climate targets they agreed to under the Paris Agreement and how they can tie this in with the broader sustainable development agenda.

Linking Climate & Development Policies: Leveraging International Networks & Knowledge Sharing (CD-LINKS) is a 4-year research project funded by the European Union with 19 partners and collaborators from Brazil, China, Europe, India, Japan, Korea, Russia, and the USA. The project explores national and global transformation strategies for climate change and their linkages to a range of sustainable development objectives.

www.cd-links.org

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