Climate Interactive Ratchet Success Pathway: Assumptions and Results

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Purpose

The purpose of this document is to explain the assumptions behind the "Ratchet Success" pathway and its results, in the context of the effort to address climate change.

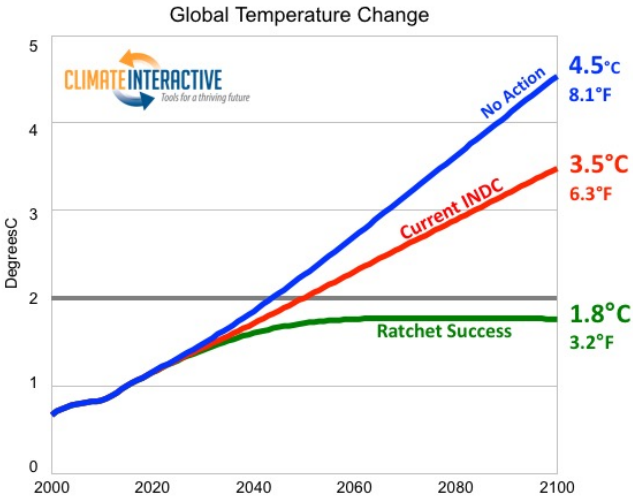

Figure 1: Global temperature results for three scenarios, including "Ratchet Success"

Summary

Climate Interactive has modeled, in the C-ROADS simulation, an emissions pathway that is consistent with staying below the current international goal of keeping climate change below a 2°C temperature rise above pre-industrial levels. The pathway provided here results in a relatively stable level of 1.8°C (3.2°F) of warming, with a range of uncertainty from 0.9 to 2.4°C (1.7 to 4.4°F). This pathway requires countries to reconvene by 2020 and significantly strengthen pledges. For all developed countries, this would mean reducing emissions 80% by 2050 from 2005 levels and for all developing countries it would mean peaking emissions just before 2030 with absolute emissions reductions thereafter. A pathway that limits warming to no more than 1.5°C (3.2°F) would require even faster reductions or net negative emissions.

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Overview

In this analysis, we consider what the contributions need to be in 2018 to ensure the world does not overshoot the 2°C (3.6°F) limit. From 2015-2020, we assume all countries begin to implement their contributions to COP21. We then explore the INDCs needed by 2020 when the nations of the world would ratchet up their pledges.

The C-ROADS Simulator

The C-ROADS (Climate Rapid Overview And Decision Support) model is designed to build shared understanding of climate dynamics in a way that is nonpartisan and rigorously grounded in the best available science, yet understandable by and useful to non-specialists, from policymakers to the public. C-ROADS:

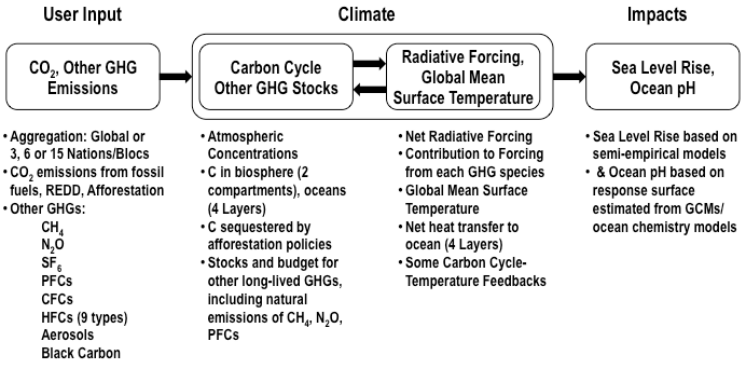

Figure 2: C-ROADS Overview

- is based on the best available peer-reviewed science and calibrated to state-of-the-art climate models;
- tracks GHGs including CO_2, CH_4, N_2O, SF_6, halocarbons, aerosols and black carbon;
- distinguishes emissions from fossil fuels and from land use and forestry policies;
- allows users to select different business as usual (BAU) scenarios, and to define their own;
- enables users to capture any emissions reduction scenario for each nation portrayed;
- reports the resulting GHG concentrations, global mean temperature change, sea level rise, ocean pH, per capita emissions, and cumulative emissions;
- allows users to assess the impact of uncertainty in key climate processes;
- is easy to use, running on a laptop computer in seconds so users immediately see the impact of the scenarios they test;
- provides an independent, neutral process to ensure that different assumptions and scenarios can be made available to all parties;
- is freely available at climateinteractive.org.

The Scenarios

Our analysis explores three scenarios, with particular emphasis on the third—Ratchet Success—modeled using the C-ROADS climate policy simulator:

1. ***No Action*** **-** Nations continue on a business-as-usual trajectory with continued emissions growth leading to 4.5°C (8.1°F)with a range of uncertainty from 2.6 to 5.9°C (4.8 to 10.6°F of warming. This scenario is calibrated to, and aligns with, the IPCC's AR5 RCP8.5 scenario.
2. ***Current INDCs*** **-** The INDCs offered as of 14 December 2015, assuming no further progress with the pledges after they end. This would put the world on track for a global temperature increase of 3.5°C (6.3°F) above pre-industrial levels, with a range of uncertainty from 2.1 to 4.7°C (3.7 to 8.4°F). For more on this scenario see: https://www.climateinteractive.org/tools/scoreboard/scoreboard-science-and-data/

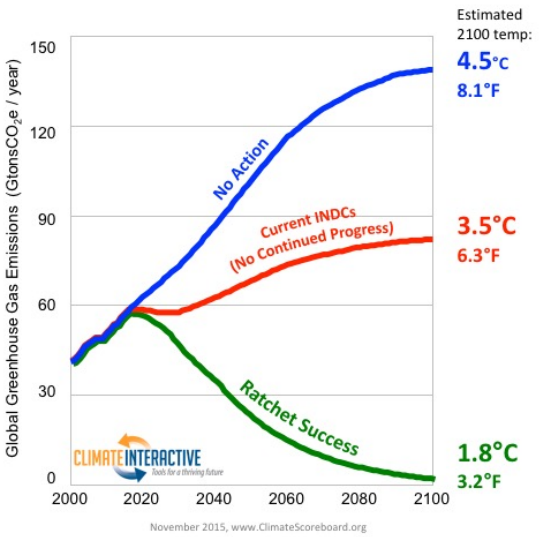

Figure 3: Global greenhouse gas emissions 2000-2100 for three scenarios, including "Ratchet Success"

3. ***Ratchet Success*** **-** INDCs are improved as per the assumptions listed below and limit warming to 1.8°C (3.2°F), with a range of uncertainty from 0.9 to 2.4°C (1.7 to 4.4°F).

Assumptions

Assumptions for the *Ratchet Success* scenario for five regions of the world are shown in Figure 4. The emissions pathways are aggregated from the 15 nations/regions used as inputs to the C-ROADS model in the *Ratchet Success* scenario.

	(Current INDC)	Improvement for 2030	2030-2050
EU	40% below 1990 levels by 2030 (45% below 2005)	47% below 1990 levels by 2030	80% below 2005 by 2050
U.S.	26% below 2005 levels by 2025	45% below 2005 levels by 2030	80% below 2005 by 2050
Other Developed	3.5% decrease below 2005 emissions by 2030*	45% below 2005 levels by 2030 (or 50% below 1990 levels)	80% below 2005 by 2050
China	Peak CO2 by 2030	Peak by 2025	Reduce 2% per year through 2040 and 4% per year after
Other Developing	10% below BAU by 2030*	Peak by 2027	Reduce 2% per year through 2040 and 4% per year after

*Level of ambition of the aggregate of individual INDCs within this group.

Figure 4: Summary of assumptions for the "Ratchet Success" scenario

Emissions pathways are provided for 15 regions through 2100 in three periods – up to 2020 following existing INDCs, 2020-2030 following the improved INDCs proposed for the Ratchet Success scenario, and then after 2030 also following the Ratchet Success Scenario.

This Ratchet Success pathway that is provided above is one of many that could limit warming to 1.8°C (3.2°F). The political and economic feasibility of these pathways is outside the scope of this analysis.

This pathway was determined by creating a scenario with C-ROADS in which annual emission reduction rates were kept to a minimal level for developing countries and the earliest action comes from developed countries first. Developing countries follow developed countries in making reductions. However, developing countries have overall lower rates of reduction, given their differentiated capacities from developed countries. For developed countries we assumed reductions could not exceed 6.5% per year (a very high rate of emission reductions) and for most developed countries reductions would not exceed 5.1%. For developing countries, we assumed a maximum reduction of 4% per year.

The rate of reductions above imply the following reductions in emissions per capita: the developed countries with their historically high levels of per capita emissions cut at 3.8%

to 6.6% per year, while developing countries reduce per capita emissions at 0.1% to 4.7% per year, with the highest reduction rates occurring after 2050. Similarly, reductions in carbon intensity (emissions per GDP) are greatest and earliest from developed countries, but note that limiting warming to no more than 2°C requires all countries to participate in reductions.

Global Climate Results

The following figures and data provide a look at the specifics of the *Ratchet Success* scenario.

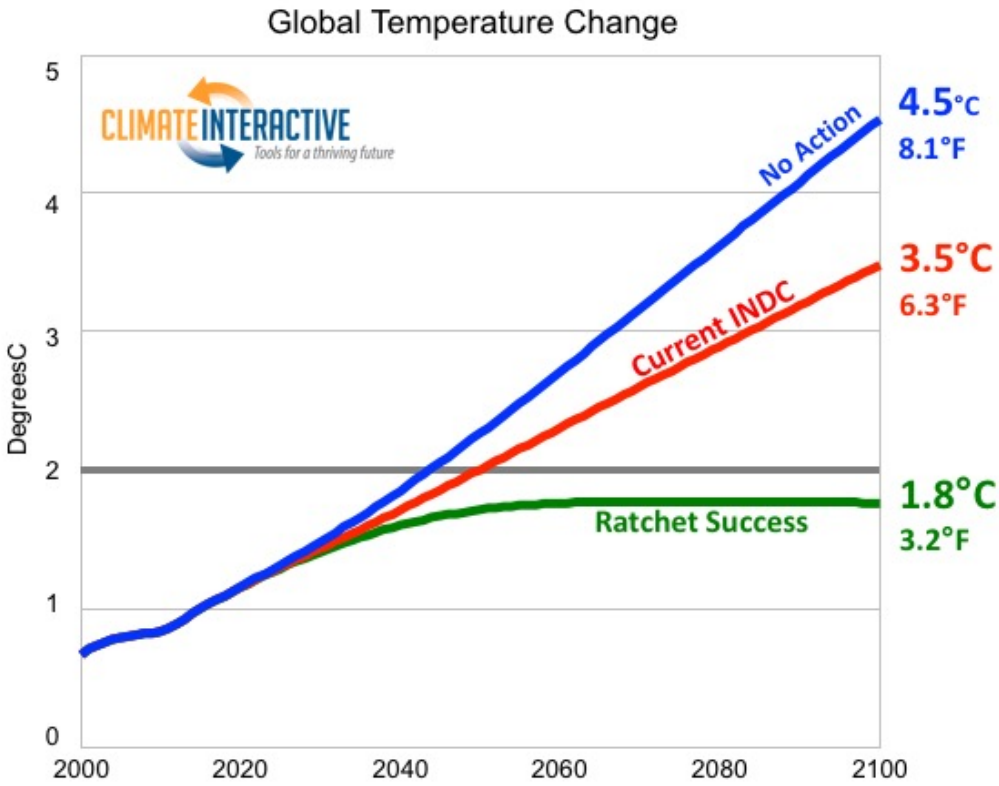

Figure 5. Expected temperature change in 2100 for the different scenarios. Ratchet Success reaches 1.8°C and stays relatively stable, while No Action and INDC Strict continue to grow beyond the end of the century.

Note: uncertainty ranges for the results shown above are:

- 4.5°C (8.1°F), with a range of uncertainty from 2.6 to 5.9°C (4.8 to 10.6°F).
- 3.5°C (6.2°F), with a range of uncertainty from 2.0 to 4.6°C (3.6 to 8.2°F).
- 1.8°C (3.2°F), with a range of uncertainty from 0.9 to 2.4°C (1.7 to 4.4°F).

Country- and Region-Level Emissions

The Ratchet Success scenario provides a significant departure from the existing reference scenario (No Action), which would provide expected warming of 4.5degC by 2100, with temperature rising beyond the end of the century. Ratchet Success is also a departure and provides a pathway beyond the existing INDCs that countries have put forward for the Pairs climate talks. The existing INDCs only go until 2030. To assess the long-term temperature trajectory in 2100, assumptions must be made about what countries do beyond the current INDCs. The INDC Strict scenario provides an analysis of the INDCs with no further action assumed. The Ratchet Success Scenario provides an assessment of the INDCs with increased ambition in five years that continues until global society is at very low emissions level near the end of the century. *See Figure 6: Change in emissions trajectories for six regions across the three scenarios.*

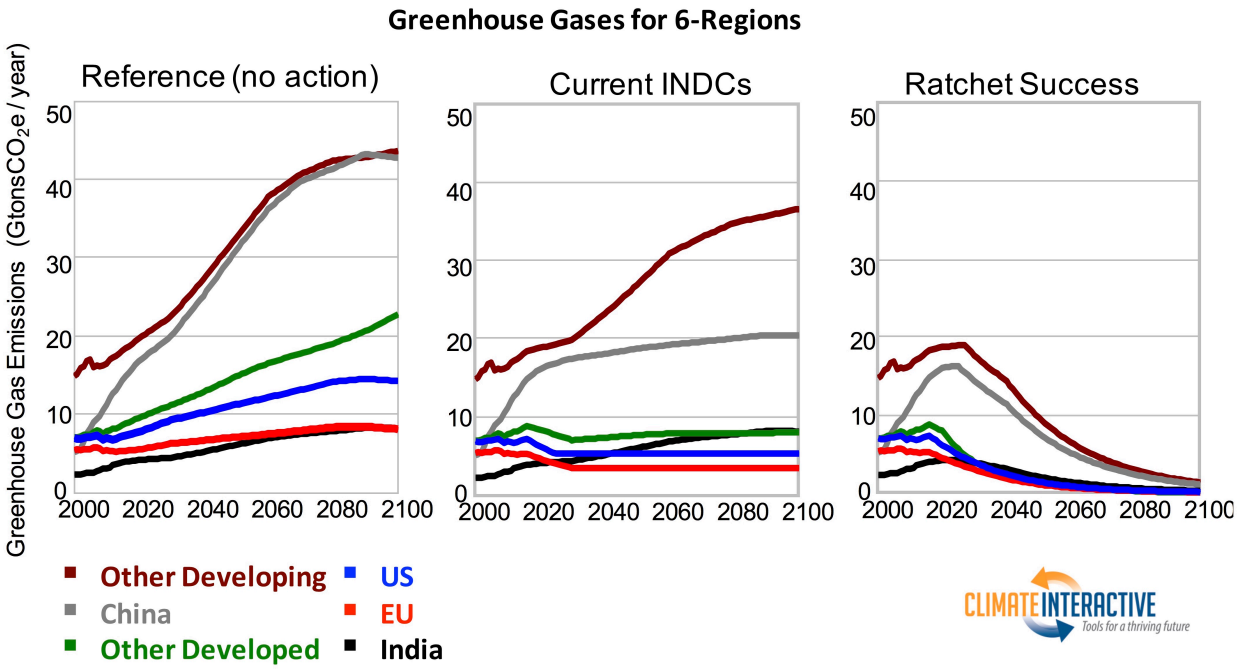

Figure 6: Change in emissions trajectories for six regions across the three scenarios.

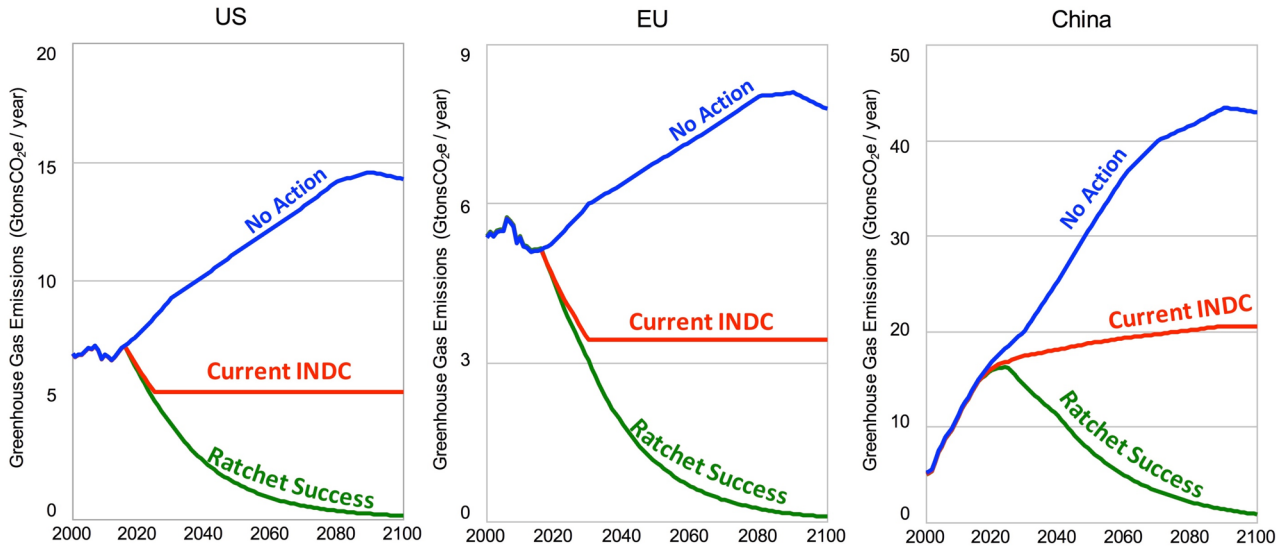

Figure 7: Total greenhouse gas emissions for the US, EU, and China from 2000-2100 under three scenarios.

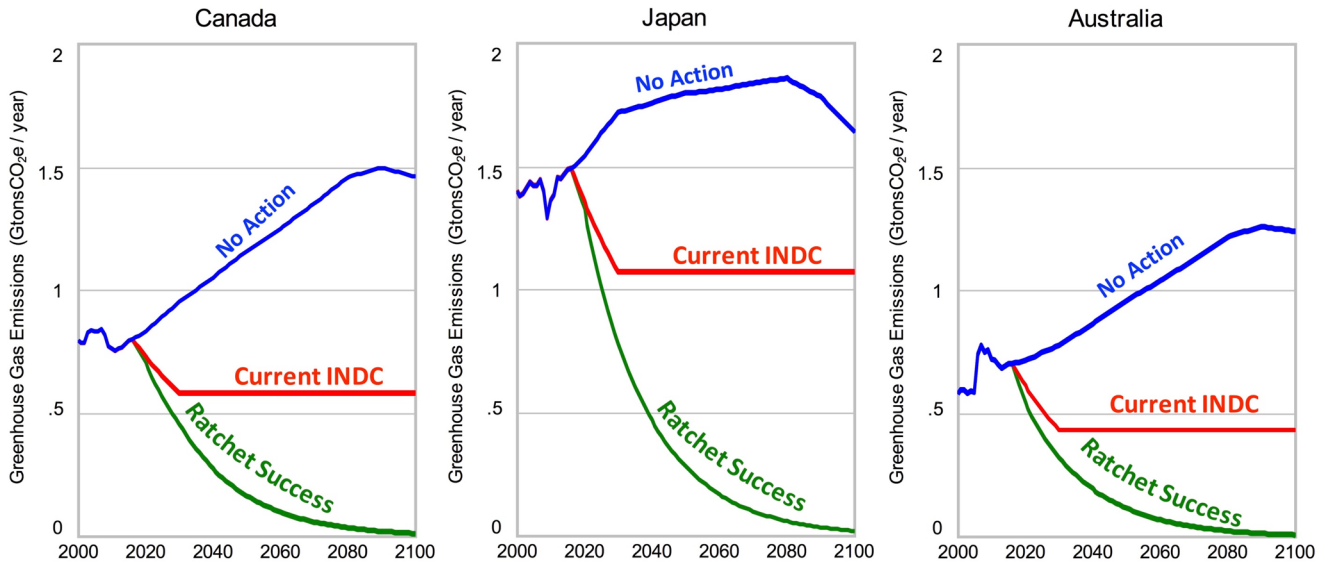

Figure 8: Total greenhouse gas emissions for Canada, Japan, and Australia from 2000-2100 under three scenarios.

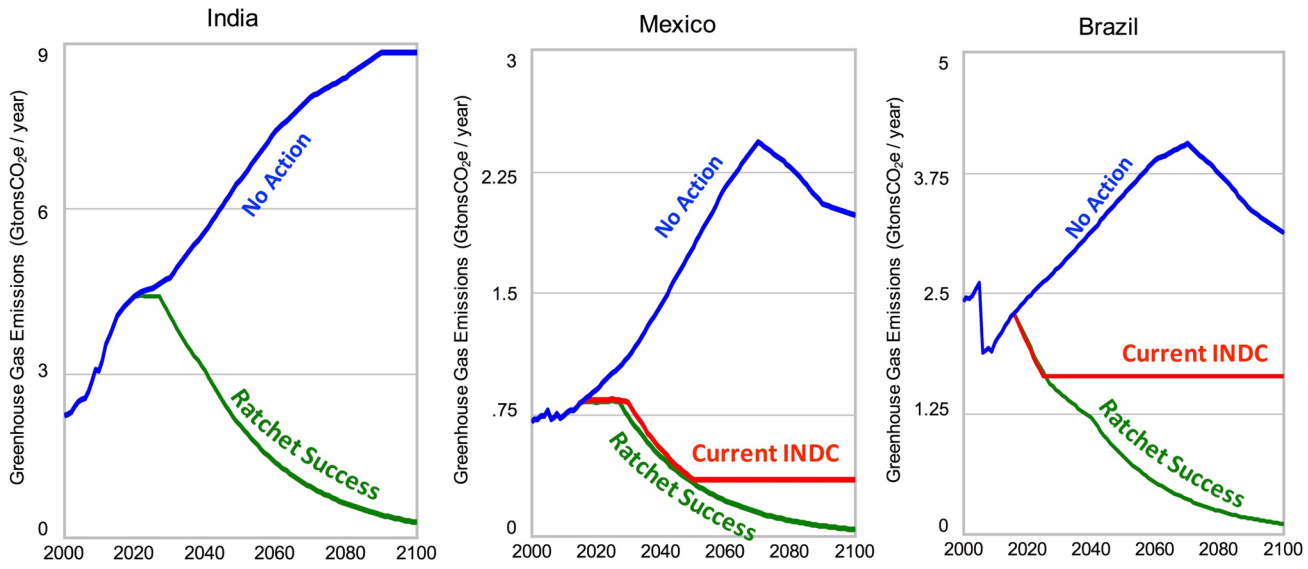

Figure 9: Total greenhouse gas emissions for India, Mexico, and Brazil from 2000-2100 under three scenarios.

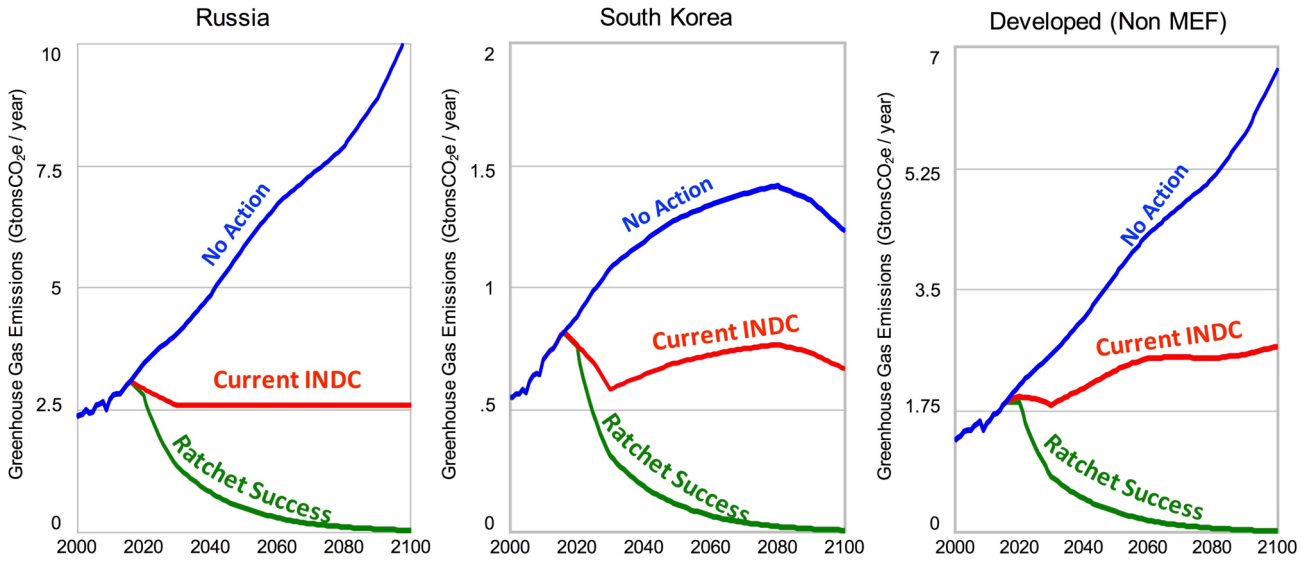

Figure 10: Total greenhouse gas emissions for Russia, South Korea, and Other Developed (Non MEF) from 2000-2100 under three scenarios.

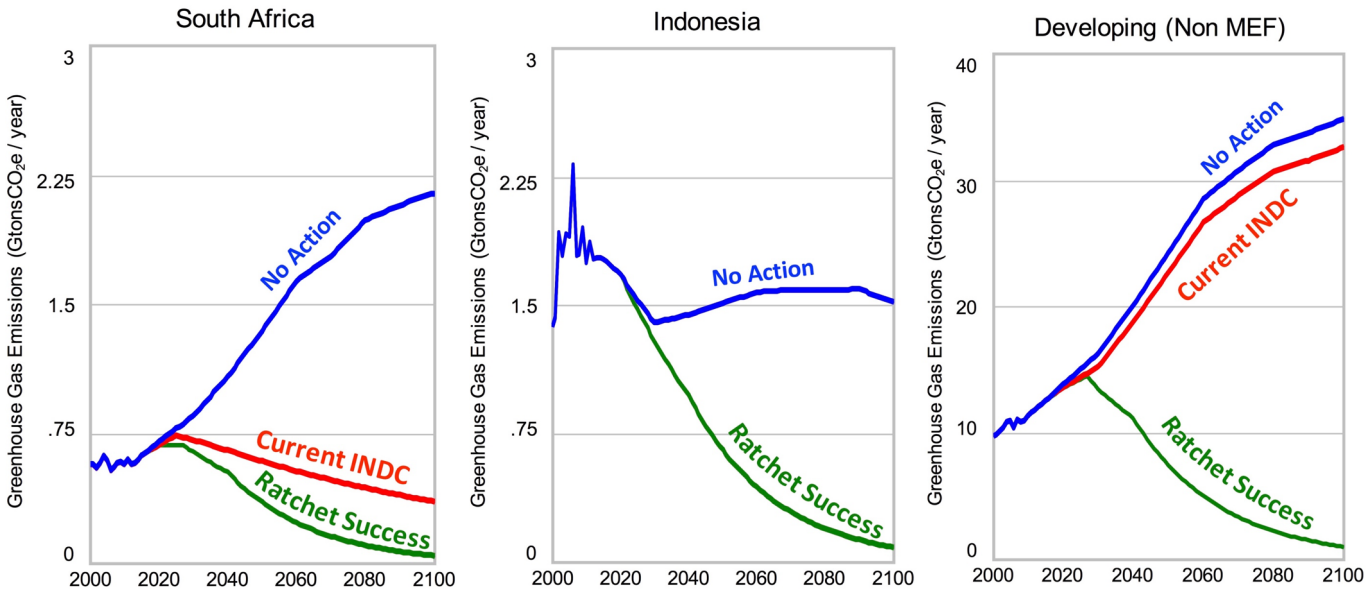

Figure 11: Total greenhouse gas emissions for South Africa, Indonesia, and Developing (Non MEF) from 2000-2100 under three scenarios.

Table 1: Annual greenhouse gas emission reduction rates over time for developed countries.

Rates of Change of Greenhouse Gas Emissions (CO_2eq): Developed Regions

		2000-2015	2015-2030	2030-2050	2050-2100
US	Ref	0.3%	1.7%	1.0%	0.5%
	Current INDC	0.3%	-2.1%	0.0%	0.0%
	Ratchet Success Pathway	0.3%	-4.1%	-5.1%	-5.1%
EU	Ref	-0.2%	1.1%	0.6%	0.3%
	Current INDC	-0.2%	-2.8%	0.0%	0.0%
	Ratchet Success Pathway	-0.2%	-3.7%	-5.1%	-5.1%
Russia	Ref	1.6%	2.0%	1.8%	1.2%
	Current INDC	1.6%	-1.0%	0.0%	0.0%
	Ratchet Success Pathway	1.6%	-5.3%	-5.1%	-5.1%
Canada	Ref	0.0%	1.2%	1.0%	0.5%
	Current INDC	0.0%	-2.1%	0.0%	0.0%
	Ratchet Success Pathway	0.0%	-3.7%	-5.1%	-5.1%
Japan	Ref	0.4%	1.0%	0.2%	-0.2%
	Current INDC	0.4%	-2.2%	0.0%	0.0%
	Ratchet Success Pathway	0.4%	-4.3%	-5.1%	-5.1%
Australia	Ref	1.2%	0.7%	1.1%	0.5%
	Current INDC	1.2%	-3.2%	0.0%	0.0%
	Ratchet Success Pathway	1.2%	-5.2%	-5.1%	-5.1%
South Korea	Ref	2.5%	2.0%	0.9%	-0.1%
	Current INDC	2.5%	-2.1%	0.9%	-0.1%
	Ratchet Success Pathway	2.5%	-6.3%	-5.1%	-5.2%
Developed (non MEF)	Ref	2.1%	2.2%	1.9%	1.2%
	Current INDC	2.1%	0.0%	1.2%	0.3%
	Ratchet Success Pathway	2.1%	-5.4%	-5.1%	-5.2%

Table 2: Annual greenhouse gas emission reduction rates over time for developing countries.

Rates of Change of Greenhouse Gas Emissions (CO_2eq): Developing Regions

		2000-2015	2015-2030	2030-2050	2050-2100
China	Ref	6.8%	2.2%	2.2%	0.7%
	Current INDC	6.8%	1.3%	0.3%	0.2%
	Ratchet Success Pathway	6.8%	0.1%	-3.2%	-4.0%
India	Ref	3.6%	0.9%	1.6%	0.6%
	Current INDC	3.6%	0.9%	1.6%	0.6%
	Ratchet Success Pathway	3.6%	0.0%	-3.1%	-4.0%
Indonesia	Ref	1.7%	-1.6%	0.4%	0.0%
	Current INDC	1.7%	-1.6%	0.4%	0.0%
	Ratchet Success Pathway	1.7%	-2.1%	-3.4%	-4.0%
Mexico	Ref	1.0%	2.0%	2.4%	0.2%
	Current INDC	1.0%	0.1%	-4.3%	0.0%
	Ratchet Success Pathway	1.0%	-0.7%	-4.0%	-4.0%
Brazil	Ref	-0.5%	1.4%	1.2%	-0.2%
	Current INDC	-0.5%	-2.1%	0.0%	0.0%
	Ratchet Success Pathway	-0.5%	-2.8%	-3.0%	-4.0%
South Africa	Ref	0.5%	2.1%	2.3%	0.9%
	Current INDC	0.5%	0.9%	-0.9%	-1.0%
	Ratchet Success Pathway	0.5%	0.3%	-3.0%	-4.0%
Developing (non MEF)	Ref	1.7%	1.7%	2.0%	0.7%
	Current INDC	1.7%	1.3%	2.0%	0.7%
	Ratchet Success Pathway	1.7%	0.5%	-3.0%	-4.0%

Per Capita and Emissions Intensity Results

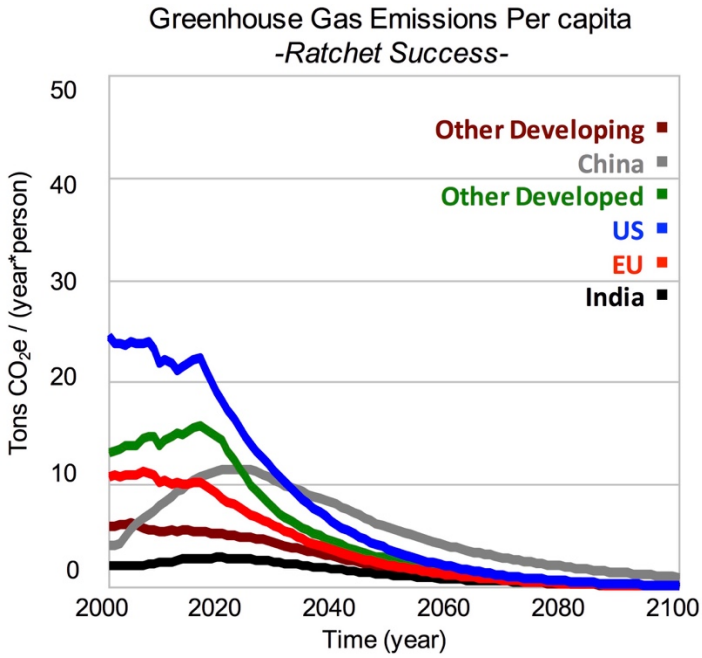

Figure 12: Greenhouse gas emissions per capita for six regions.

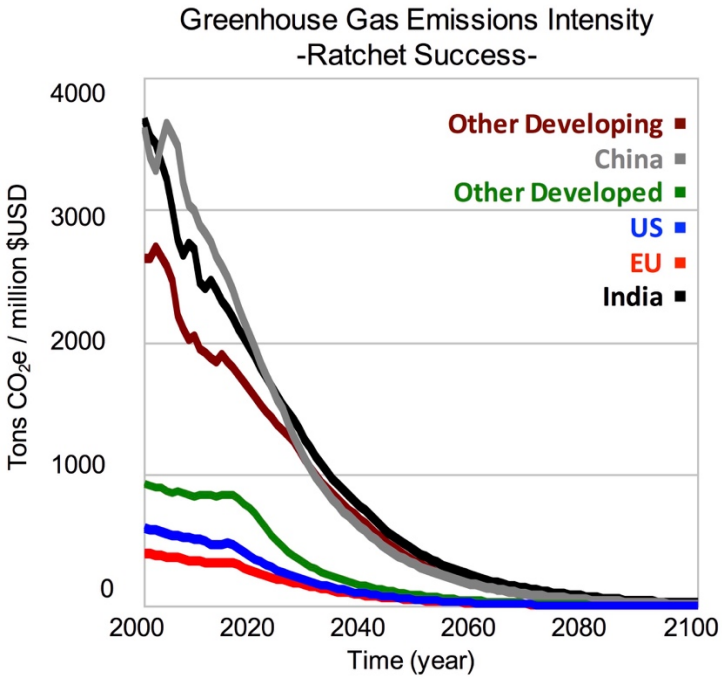

Figure 13: Greenhouse gas emissions intensity for six regions. Emissions intensity is measured as the emissions released per dollar of GDP.

Why are such significant long term cuts in emissions necessary?

Limiting expected warming to no more than 2°C (3.6°F) requires deeper, steeper, and earlier reductions in global greenhouse gas emissions than the current INDCs would achieve. Why? It's a matter of basic physics: Today we are spewing CO_2 and other greenhouse gases into the atmosphere more than twice as fast as they are being removed. If you fill your bathtub twice as fast as water drains out, the level of water in the tub will rise until it overflows and ruins your house. The pledges to date slow the growth of emissions. But larger cuts are needed to balance the tub—to stop the growth of greenhouse gas concentrations in the atmosphere.

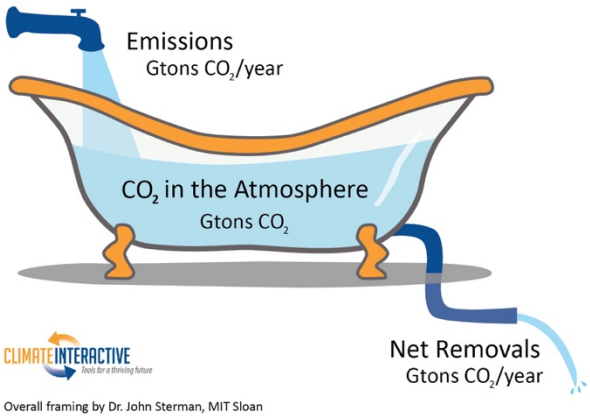

Figure 14: The Carbon Bathtub

The developed nations must cut their emissions more than called for by their INDCs. But global emissions cannot fall enough to limit warming unless the developing nations also reduce their emissions. That does not mean that the poorest nations must sacrifice their development to do it. The developed countries should cover the cost of emissions reductions in the developing world so these nations can leapfrog the polluting fossil fuel infrastructure through clean, renewable energy and efficient end use, just as Africa jumped straight to mobile telephony, leapfrogging land lines.

Appendix A

Table 3: National groupings for C-ROADS.

Six Regions	MEF Categories	MEF Regions	Individual Nations
United States (US)	Developed Nations in MEF	United States (US)	United States (US)
European Union (EU)		European Union (EU) 27 (EU27) (plus Iceland, Norway and Switzerland)	Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxemburg, Malta, the Netherlands, Poland, Portugal, Romania, Slovakia, Spain, Sweden and the United Kingdom, Iceland, Norway and Switzerland. (includes former Czechoslovakia)
Other Developed Countries		Russia	Russia (includes fraction of former USSR)
		Canada	Canada (includes rest of other North America)
		Japan	Japan
		Australia	Australia
		South Korea	South Korea
	Developed Non MEF	New Zealand	New Zealand
		Other Eastern Europe	Albania, Bosnia & Herzegovinia, Croatia, Macedonia, Slovenia, Armenia, Azerbaijan, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, Ukraine, Uzbekistan (includes former Yugoslavia and fraction of former USSR)
China	Developing Nations in MEF	China	China
India		India	India
Other Developing Countries		Indonesia	Indonesia
		Brazil	Brazil
		South Africa	South Africa
		Mexico	Mexico
	Developing Non MEF	Other Large Developing Asia	Philippines, Thailand, Taiwan, Hong Kong, Malaysia, Pakistan, Singapore
		Middle East	Bahrain, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Oman, Qatar, South Arabia, Syria, Turkey, United Arab Emirates, Yemen, West Bank and Gaza (Occupied Territory)
		Other Latin America	Argentina, Chile, Colombia, Peru, Uruguay, Venezuela, Bolivia, Costa Rica, Cuba, Dominican Rep., Ecuador, El Salvador, Guatemala, Haïti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Puerto Rico, Trinidad and Tobago, and Caribbean Islands
		Other Africa	Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoro Islands, Congo, Côte d'Ivoire, Djibouti, Equatorial Guinea, Eritrea and Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Liberia, Libya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Reunion, Rwanda, Sao Tome & Principe, Senegal, Seychelles, Sierra Leone, Somalia, South Sudan, Sudan, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zaire, Zambia, Zimbabwe, Mayotte, Saint Helena, West Sahara
		Other Small Asia	Bangladesh, Burma, Nepal, Sri Lanka, Afghanistan, Cambodia, Laos, Mongolia, N. Korea, Vietnam, 23 Small East Asia nations