

Impact of Current Climate Proposals

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Abstract

This article investigates the temperature reduction impact of major climate policy proposals implemented by 2030, using the standard MAGICC climate model. Even optimistically assuming that promised emission cuts are maintained throughout the century, the impacts are generally small. The impact of the US Clean Power Plan (USCPP) is a reduction in temperature rise by 0.013°C by 2100. The full US promise for the COP21 climate conference in Paris, its so-called Intended Nationally Determined Contribution (INDC) will reduce temperature rise by 0.031°C. The EU 20-20 policy has an impact of 0.026°C, the EU INDC 0.053°C, and China INDC 0.048°C. All climate policies by the US, China, the EU and the rest of the world, implemented from the early 2000s to 2030 and sustained through the century will likely reduce global temperature rise about 0.17°C in 2100. These impact estimates are robust to different calibrations of climate sensitivity, carbon cycling and different climate scenarios. Current climate policy promises will do little to stabilize the climate and their impact will be undetectable for many decades.

The goal of any climate policy is to reduce the very real problem of global warming. Mitigation policies focus mostly on reducing greenhouse gas emissions, thereby reducing climate change. The most prominent indicator of climate change is temperature rise. Here I define *impact* of a mitigation climate policy as its reduction in temperature rise.

To evaluate a mitigation climate policy it is crucial to know the impact of this policy. The classic article to assess a mitigation policy is Wigley (1998), which estimated the impact of the Kyoto Protocol on temperature rise and sea level rise. However, a Web of Science search does not indicate any numerical impact reviews of later significant policy proposals.¹ Thus, this article will produce an update of Wigley (1998) for the most important new climate policies, including the Intended Nationally Determined Contributions (INDCs) submitted in advance of the Paris COP21 negotiations.

Methodology

The current paper will use the same basic methodology as Wigley (1998). First, Wigley identifies the policy to be analyzed (the Kyoto Protocol). Second, he identifies the baseline of emissions – what would have happened had there been no Kyoto Protocol. Third, he makes a number of extrapolations of the Kyoto policy throughout the 21st century. Fourth, he runs the baseline and the Kyoto emissions through a climate model, evaluating the impact of the Kyoto climate policy in terms of temperature rise reduction and sea level rise reduction. Fifth, he does a sensitivity analysis by running the scenarios through more and less CO₂-sensitive models.

When identifying the climate policies to be analyzed, we can identify the most important in terms of CO₂ reduction from the recent overview of the INDCs by Boyd, Turner and Ward (2015). Here they find the reductions of the US, the EU and China to constitute 75–81 per cent of all reductions in 2030. The updated analysis provided below finds a pretty sim-

ilar total reduction from the US, the EU and China, although the US reductions are much lower and the EU reductions much higher than found in Boyd, Turner and Ward (2015). Finally, the analysis includes the totality of all the INDC promises, including the remaining 22 per cent from Canada, South Korea, Russia, Japan etc.

There are a vast number of potential baselines. We need both a global baseline and a policy-relevant baseline, e.g. for the EU or China. For a global baseline, Wigley (1998) uses the original Intergovernmental Panel on Climate Change (IPCC) business-as-usual (BAU) scenario, IS92a. This has since been superseded by two newer scenario collections, the Special Report on Emissions Scenarios (SRES) from 2000 and the Representative Concentration Pathways (RCP) from 2011, neither of which have a simple BAU scenario. Indeed, the RCP scenarios are predominantly climate science focused, and do not have any consistent socioeconomic design (van Vuuren et al., 2011). For the most recent IPCC report, AR5, the literature holds about 250 BAU scenarios (UNEP, 2014, p. 34). The choice of global BAU scenario determines the *absolute* temperature. Since we are interested in the *difference* between a BAU scenario and the similar BAU scenario with a policy emission reduction, the global BAU scenario decision matters little. Here I use the RCP8.5, which is regarded as a worst-case scenario. Sensitivity analysis shows that the results change little when using other scenarios like RCP6 and SRES A1B, which are better-case outcomes. The median of the main AR5 BAU scenarios used below lie right inbetween RCP8.5 and RCP6 (see supplementary information).

For the BAU scenarios for the US, the EU, and China, I use the official baseline for the US Energy Information Agency (EIA) (EIA, 2015a), and the median of the latest two big socioeconomic studies of the EU (Energy Modeling Forum 28; Knopf et al., 2013) and of China (Asia Modeling Exercise (Calvin et al., 2012)).

To predict the actual emission reductions up to the formal end-point of the Kyoto Protocol, Wigley assumes all actors do everything they promise without any other adverse effects. Kyoto promised to cut the emissions of industrialized countries (the Annex B) by 2008–2012 by 5.2 per cent below 1990-level emissions. Wigley supposes that industrialized emissions decline linearly towards 5 per cent below 1990-level by 2010, resulting in an annual emission of 2.7Gt CO₂ below the baseline. He also implicitly assumes no carbon leakage – that some industries responsible for significant emissions in the EU and the US shift to non-Kyoto countries like China. Research indicates that the size of the carbon leakage could be anywhere from 5–40 per cent (Bernstein, Montgomery and Rutherford, 1999; Felder and Rutherford, 1993; Burniaux and Martins, 2012; Elliott et al., 2010; Paltsev, 2001) and could even sometimes be as high as 130 per cent (Babiker, 2005). That means that instead of Kyoto reducing 2.7Gt CO₂ per year, emission increases elsewhere would reduce the global reduction to 1.6–2.6Gt CO₂ and possibly even lead to increased emissions. A recent study estimates the actual leakage at 40 per cent (Aichele and Felbermayr, 2014).

In the following I will describe assumptions that make temperature rises drop more as optimistic, and the opposite assumptions pessimistic. It is clear that Wigley (1998) made two optimistic assumptions here: both assuming that all actors will do what they promise (which of course did not happen with the Kyoto Protocol) and assuming no carbon leakage, which also did not happen. However, I will nevertheless make similar assumptions below, underlining that the results here are inherently optimistically skewed.

Wigley also made assumptions about what happens after the policy end-point of 2010, since this is crucial for the climate impact. He suggests three scenarios. The first scenario expects that the annual 2.7Gt CO₂ reduction will be honored in perpetuity (i.e. emissions will start rising after 2010, but constantly 2.7Gt below what the baseline would have expected). The second scenario assumes that industrialized countries' emissions will remain constant after 2010, which means ever stronger emission cuts from the baseline, cutting 7.9Gt CO₂ annually by 2100. The third scenario somewhat arbitrarily assumes that Annex B countries would reduce their emissions even further after 2010 by 1 per cent per year, leading to emission reductions by the end of the century of 16Gt CO₂ annually, 74 per cent below the expected emissions.

These scenarios are heavily skewed towards an optimistic interpretation. The first scenario assumes that the political promise of the Kyoto Protocol would be continued for nine decades after it formally runs out, which clearly did not happen. However, the other two scenarios are essentially analyses of other political agreements beyond the Kyoto Protocol. The second scenario assumes that the Kyoto Protocol was binding not only in 2010, but forever. The third scenario assumes an entirely different treaty with very significant reduction promises all the way to 2100.

For analysis of political promises, I propose we should analyze just that policy not any later follow-on policies. Moreover, we should analyze it with an optimistic and a

pessimistic scenario. Thus, for the Kyoto Protocol, this approach would suggest an optimistic scenario like Wigley's first scenario, where the treaty countries would maintain their reduction promises infinitely. The pessimistic scenario would still assume the countries live up to their promises by 2010, but then falter after that and eventually return to the baseline emissions. Notice, both scenarios still assume that the promised policy will be carried out without carbon leakage, only with different policy intensity after the promise runs out. This means that the results can be understood as the outcome of the promised policy, where the likelihood of that policy actually being implemented can be separately assessed.

In the supplementary information, I also contrast the results with two unrealistically optimistic scenarios, one assuming ever higher reductions with the optimistic reduction rate extended throughout the century and one assuming a complete cessation of emission increases.

For the following analyses we need to make assumptions about the longer-term promises. When for instance the EU promises to cut its emissions by 40 per cent in 2030, this is already very far away. Promises of what will happen in 2050 (80 per cent reduction in both the EU and the US) or promises for the G7 to entirely decarbonize by 2100 are not as much actual policies but more political hand waving. Thus, for this paper, I will investigate policies that have practical political implications soon and have a verifiable outcome by 2030, but not policies that promise actions only or mostly starting after 2030. Of course, policies that can be evaluated by 2030 will still impact emissions long after 2030, and hence affect the temperature trajectory all the way to the end of the century.

Wigley then runs the baseline scenario and the three Kyoto scenarios with a standard simple climate model used by the IPCC. We will here use MAGICC 6.3 (Meinshausen, Raper & Wigley, 2011). This is the latest version of a simple climate model used in all the five IPCC assessment reports from 1990–2014.²

Wigley also assumes that only reductions in CO₂ (not other greenhouse gasses) are used to achieve the target. As is standard, I use the IPCC conversion of non-CO₂ emissions according to their 100-year global warming potential (IPCC, 2013, p. 1302).

Wigley uses 2100 as his end-point, although climate change of course will continue into the following centuries. He finds that with his central climate sensitivity estimate the baseline temperature increases from 0 in 1990 to 2.07°C by 2100, but with the constant 2.7Gt CO₂ reduction the temperature by 2100 is 1.99°C. Thus the temperature rise reduction by 2100 from the constant Kyoto scenario is 0.08°C. Here we will say the impact of the optimistic Kyoto Protocol scenario is a temperature rise reduction of 0.08°C.

As a sensitivity analysis he estimates the impact with almost half and almost double the climate sensitivity and finds that the impact remains at the same relative level (same proportion of temperature reduction of the total temperature rise).

In the following, I use the methodology outlined above to assess the impact on the climate of policies including the

main INDC commitments in preparation for COP21. I will use the default values of MAGICC as the standard run (with a climate sensitivity of 3°C). Sensitivity analysis shows that different assumptions of climate sensitivity and of carbon cycle model do not substantially change the outcome (see supplementary information).

US Clean Power Plan

The US Clean Power Plan (USCPP) was published on 3 August 2015 and requires the US power sector to reduce its CO₂ emissions by 32 per cent below 2005 levels by 2030.³ This is equivalent to a reduction per annum of 773Mt CO₂ below 2005-levels by 2030. Since the power sector contributes 38 per cent of all US energy-related CO₂ emissions, 773Mt CO₂ is a 14 per cent reduction of total US 2015 emissions.⁴ Here we estimate the climate impact of this policy.

The US has an official baseline until 2040 from the EIA (EIA, 2015a). Its reference case from the 2015 Annual Energy Outlook explicitly excludes the impact of the USCPP or other actions beyond current policies to limit or reduce CO₂ emissions.⁵ The EIA estimates that the power sector CO₂ emissions in 2005 were 2,415Mt, which dropped significantly to 2,054Mt in 2015 and in the reference case will increase to 2,177Mt by 2030. The impact of the USCPP is to reduce that annual emission in 2030 to 1,642Mt (32 per cent below 2005 levels). By 2030 that amounts to a 535Mt reduction, see Figure 1.

Since much of the promised reduction has already occurred, only the reduction that comes from 2016–2030 can be considered the impact of USCPP.

The baseline scenario runs to 2040 and almost stabilizes. Here we will assume that power emissions would have remained stable at 2040 level for the rest of the century.

For the USCPP emission reductions after 2030, an optimistic extrapolation would expect that the reduction remains constant across the century at 535Mt below the

baseline scenario. The pessimistic scenario sees the promise slowly evaporating after 2030, here modeled as a halving of the emission reduction every decade.

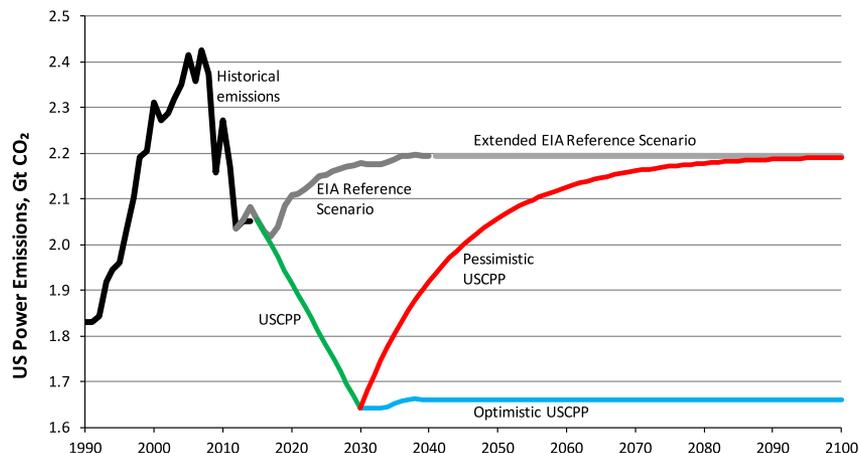
The pessimistic interpretation implies that there is a real cost involved in limiting CO₂ emissions and when the restriction is lifted, the system will trend back towards higher emissions. The optimistic interpretation implies that there is essentially no onwards cost after 2030 for keeping the system permanently at the new, lower CO₂ emission level. It seems likely that the real outcome lies somewhere in-between.

Some might argue that given a successful completion of the USCPP emission path, this will inspire further political action both domestically and internationally. However, the past experience of e.g. the Kyoto Protocol, does not seem to suggest this is a generally valid point. Clearly, strong action from some parties can make it easier for others to engage in more ambitious climate policies, but likewise it can make it easier for others to free-ride. While the EU climate policies likely inspired Norway, Japan and earlier Australia, it is clear that it did not get many of the other participants onboard (Canada, the US, later Australia, along with most other countries).

Climate impact of USCPP

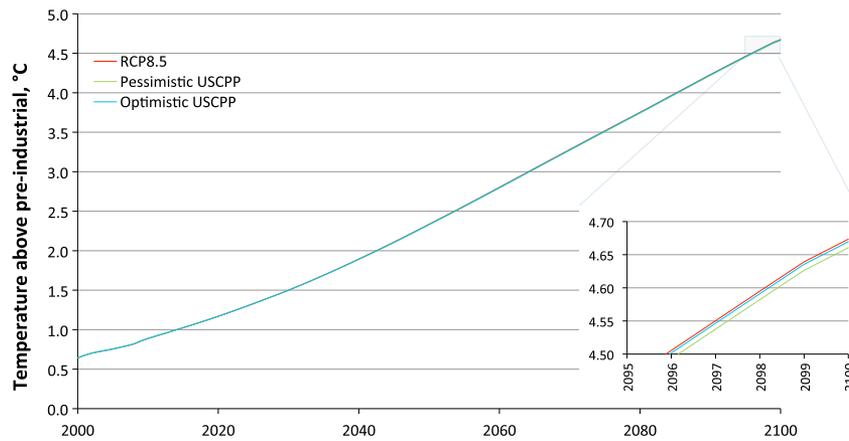
We estimate the climate impact of the USCPP as the difference in temperature outcome in MAGICC from unrestricted RCP8.5 emissions across the century with the lower emissions that would occur with an optimistic or pessimistic USCPP scenario. So in the optimistic scenario, we would see a gradual reduction of annual RCP8.5 emissions by 535Mt CO₂ by 2030, continued throughout the century, as depicted in Figure 1. As seen in Figure 2, the temperature reduction for the pessimistic scenario is 0.004°C by 2100 and for the optimistic scenario 0.013°C, with an average of 0.008°C.

Figure 1. US power emissions 1990–2100.



Note: US historical power emissions 1990–2014 (EIA, 2015c), EIA baseline 2012–2040 and extension to 2100 (EIA, 2015b, table 18), optimistic and pessimistic USCPP reductions (see text).

Figure 2. Global temperature anomaly from 2000–2100 with baseline RCP8.5, and optimistic and pessimistic US Clean Power Plan (USCPP) run on MAGICC, enlarged insert at right-hand corner.



Sensitivity on scenario and climate models

When run in an RCP6 world, the temperature reductions from the USCPP are of the same magnitude, but about 18 per cent higher at 0.015°C and 0.004°C, a result that is consistent across the investigated scenarios below (see supplementary information). In the following we will only look at RCP8.5.

When run across all available climate models and carbon cycle settings in MAGICC, the differences are very slight for all policies (see supplementary information). Thus, we will in the following just use the default setting for MAGICC.

US proposed Paris reduction

Following up on its promise to reduce emissions by 17 per cent from 2005 in 2020, the US has promised in its INDC for Paris to reduce its CO₂ equivalent emissions 26–28 per cent below 2005 levels by 2025 (USINDC, 2015). According to the IEA, this means that the US is projected to deliver the largest

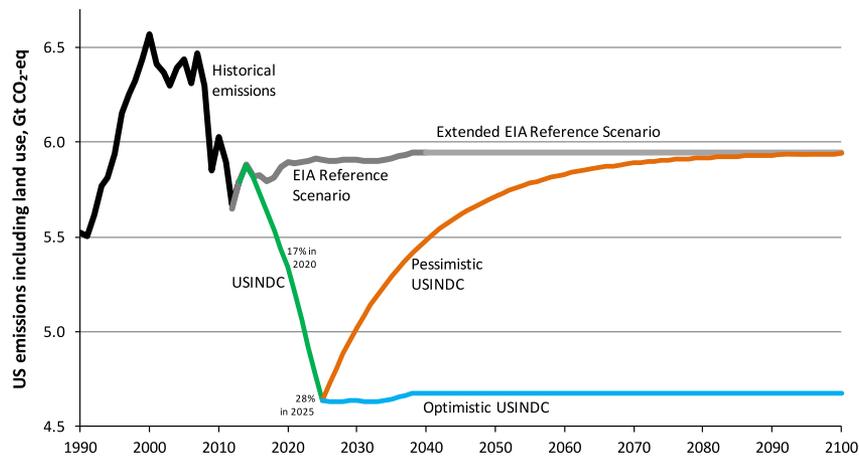
absolute reduction in energy-related CO₂ emissions of any country in the world from 2013 to 2025 (IEA, 2015, p. 43).

The US is very clear in its submission that this is a one-point promise in 2025: ‘The US target is for a single year: 2025.’

The emission promise is based on net CO₂ equivalents including land use change and forestry, from 6.44Gt in 2005 to 4.63Gt in 2025, see Figure 3. As in (Wigley, 1998), I will assume that CO₂ reductions alone are used to achieve the reduction. Again, I will use the EIA reference case as baseline (it only measures fossil fuel CO₂ emissions, so it is about 7 per cent too low, adjusted here to the latest 2013 data). Like before, we assume flat emissions from 2040 onwards.

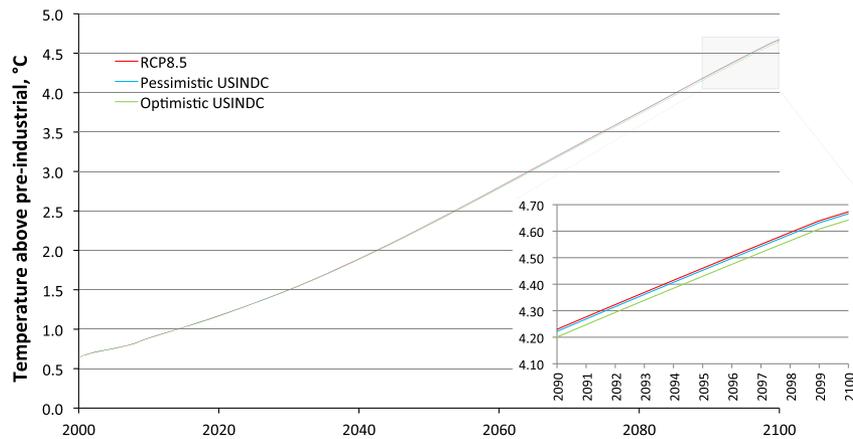
Notice, earlier baseline scenarios like the Energy Modeling Forum for the US (known as EMF24 (Fawcett et al., 2014)) estimate a somewhat steeper increase in emissions across the first half of the century, to a large extent because they do not include the shale gas boom, which has reduced and will likely continue to reduce CO₂ emissions. An average of the six EMF24 baseline scenarios sees just CO₂ emissions by

Figure 3. US greenhouse gas (GHG) emissions including land use, 1990–2100.



Note: Historic emissions 1990–2013 (EPA, 2015, Table ES-2), adjusted baseline scenario 2012–2040 (EIA, 2015a), extended baseline to 2100, and optimistic and pessimistic USINDC emission reductions (see text).

Figure 4. Global temperature anomaly from 2000–2100 with baseline RCP8.5, and optimistic and pessimistic US Paris promise (USINDC), run on MAGICC.



2030 at 6Gt against the EIA's estimate of 5.5Gt. Thus, using these older scenarios would implicitly credit climate policies with future emission reductions that in reality came from the shift towards gas caused by the shale gas revolution. This is even more pronounced in the baseline scenario from Boyd, Turner and Ward (2015), which envision CO₂-equivalent emissions of 6.8Gt by 2030 compared to the approximately 5.9Gt from the EIA. This is why the current study finds a significantly lower emission reduction from the USINDC than does (Boyd, Turner and Ward, 2015).

We will assume the US reaches the promised 17 per cent reduction in 2020 and the maximal 28 per cent in 2025. From then on, the pessimistic scenario sees a return to the baseline, and the optimistic scenario sees the numerical reduction continued forever.

Climate impact of USINDC

Given that the USINDC reduction is about 1.26Gt, delivered faster and is more than twice as large as the reduction in

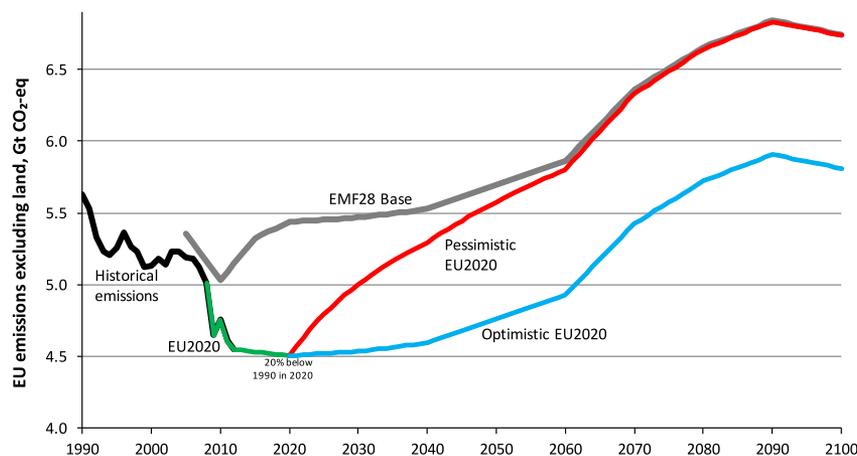
the USCPP, the temperature impact is also more than twice as large. As with the USCPP, we estimate the climate impact of the USINDC as the difference in temperature outcome in MAGICC from unrestricted RCP8.5 emissions across the century with the lower emissions that would occur with an optimistic or pessimistic USINDC scenario.

Figure 4 shows that the pessimistic scenario results in a temperature reduction of 0.008°C by 2100, and the optimistic scenario reduce temperatures by 0.031°C, at an average of 0.020°C. This means that the additional impact of the US Paris promise (beyond the USCPP) is 0.011°C (0.004–0.019°C).

EU 2020 policy

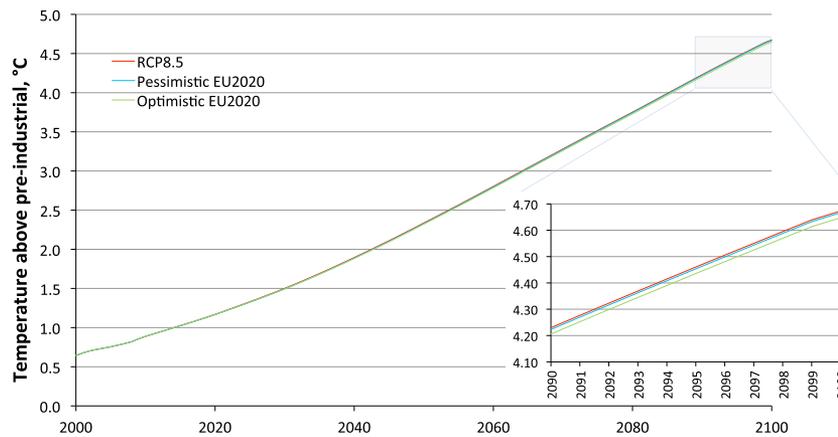
The EU decided in 2007 and legislated in 2009 to reduce its greenhouse gas emissions excluding land use to 20 per cent below 1990-levels by 2020.⁶ Here I will look only at the largest EU grouping, the EU28. As is evident in Figure 5, the EU was already in 2012 very close to reaching its target for 2020, having reduced its emissions to 19.25 per cent below 1990-levels.

Figure 5. EU28 GHG emissions excluding land use, 1990–2100.



Note: Historic emissions 1990–2012 ((EEA, 2014; with data from EEA, 2015)), baseline emissions 2005–2100 from EMF28 (Knopf et al., 2013) with optimistic and pessimistic EU 20 per cent reduction by 2020 (see text).

Figure 6. Global temperature anomaly from 2000–2100 with baseline RCP8.5, and optimistic and pessimistic EU 2020 policy, run on MAGICC.



For the baseline, we use the median of the 14 baselines in the latest Energy Modeling Forum for the EU (the so-called EMF28 (Knopf et al., 2013)) with data from (IIASA, 2015)).⁷ This median baseline scenario has slightly higher emissions than the EU historical data in 2005, expected some reduction in emissions in 2010 from the global recession, but saw a quick return to increasing emissions by 2015 onwards. As before, we estimate the optimistic EU2020 as an indefinite continuation of the absolute reduction achieved by 2020, and the pessimistic EU2020 as a halving of the absolute reduction each decade after 2020.

Figure 6 shows that the pessimistic EU 2020 policy results in a temperature rise reduction of 0.007°C, and the optimistic scenario sees a temperature rise reduction of 0.026°C, with a 0.016°C average.

EUINDC 2030 policy

EU promises in its INDC to reduce its emissions to below 40 per cent under 1990 emissions (EUINDC, 2015). It made the

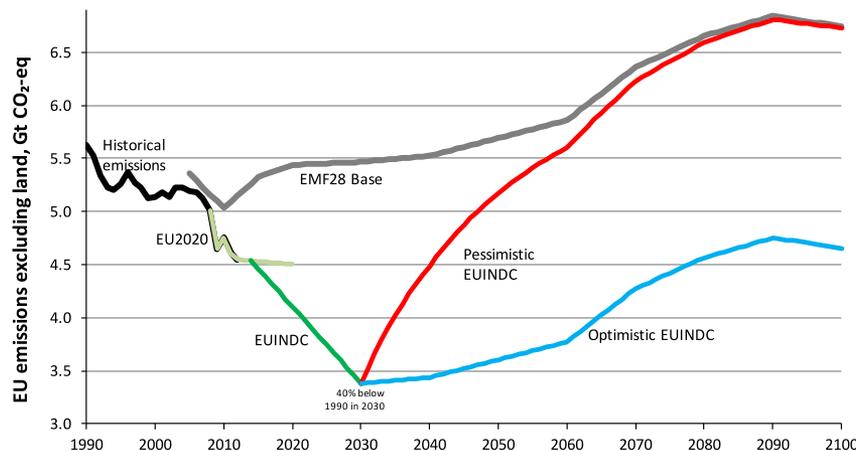
decision in late 2014⁸, so I model the emission reductions beginning in 2015, as seen in Figure 7.

Notice that this promise is going to be a lot harder than the first 20 per cent promise. A large part of early EU28 reduction came from the collapse of Eastern Europe with the Soviet Union in the 1990s (the EU15 reduction is much smaller), and because of the sharp reduction from the 2008 financial crisis. In order to live up to the 40 per cent reduction promise, the IEA estimates that the EU will have to reduce its energy-related CO₂ emissions almost twice as fast as what has been observed since 2000 (IEA, 2015, p. 47).

We are comparing here the EU climate policy with a baseline not even attempting the full 20 per cent reduction by 2020. That means the total emission cut is much larger than the one estimated by Boyd, Turner and Ward (2015).

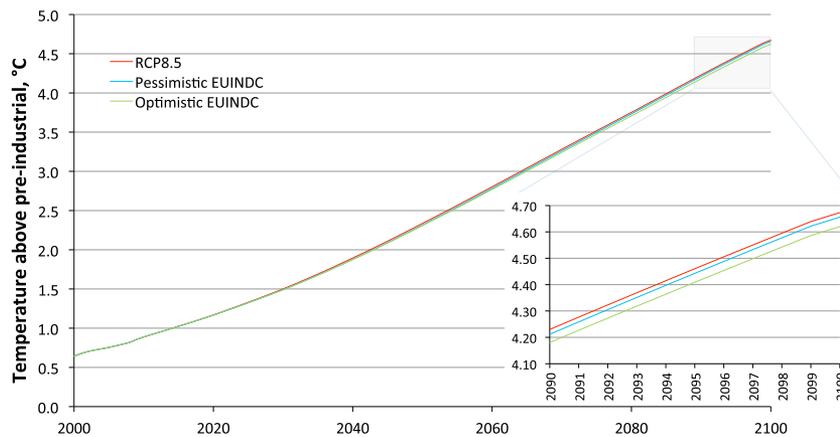
The impact as run on MAGICC is shown in Figure 8. The temperature reduction by 2100 is 0.053°C in the optimistic scenario and 0.017°C in the pessimistic scenario, with an average of 0.035°C. The added impact of the EU 40 per cent reduction over the EU2020 is 0.019°C.

Figure 7. EU28 GHG emissions excluding land use, 1990–2100.



Note: Historic emissions 1990–2012 ((EEA, 2014; with data from EEA, 2015)), baseline emissions 2005–2100 from EMF28 (Knopf et al., 2013) with optimistic and pessimistic EUINDC, promising 40 per cent reduction by 2030 (see text).

Figure 8. Global temperature anomaly from 2000–2100 with baseline RCP8.5, and optimistic and pessimistic EU Paris promise (EUINDC), run on MAGICC.



China 2030 INDC policy

China's INDC has made two significant promises (China INDC, 2015). One is a promise to peak its emissions around 2030. That is a promise, which will only start having a policy impact around and after 2030, which falls outside the 2030 time limit for policy promises set in this article.

The other promise seeks to reduce China's CO₂ intensity by 60–65 per cent, compared to 2005. Unlike China's 2020 promise to reduce its CO₂ intensity by 40–45 per cent, which was likely to be achieved even in the absence of climate policies (Calvin et al., 2012, s258; Calvin, Fawcett and Kejun, 2012, s311), this promise will likely lead to real emission cuts.

As baseline emissions, we will use the median of the Asia Modeling Exercise (Blanford, Rose and Tavoni, 2012), which involved 18 models. Using the median for GDP estimates, we find that without policy change, China will only reduce its CO₂ intensity by 54 per cent by 2030. Reducing it to 60

per cent will require a further 1.9Gt CO₂ emissions cut by 2030, being implemented linearly from 2016, as shown in Figure 9.

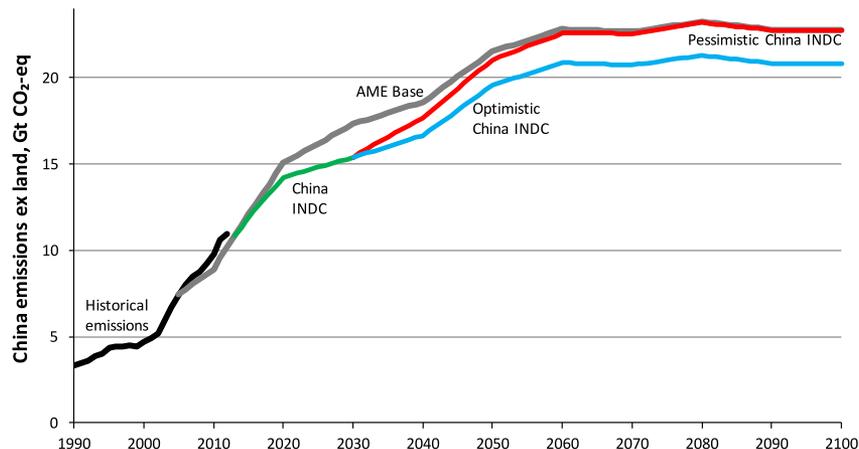
Figure 10 shows the China INDC impact run on MAGICC. By 2100, it will result in a reduction in temperature rise of 0.048°C in the optimistic case and 0.014°C in the pessimistic case, with an average of 0.031°C.

Total impact of Paris COP21

Boyd, Turner and Ward (2015) estimate the current total INDC emission cut by 2030 of between 5.3–7.5Gt CO₂-equivalent, whereas (CAT, 2015) estimates a reduction of 1–8Gt, implying a 4.5 Gt midpoint. The UNFCCC Synthesis report from October 30 finds an emission reduction of 0–7.5Gt CO₂, with a best estimate of 3.6Gt CO₂ (UNFCCC 2015, p10).

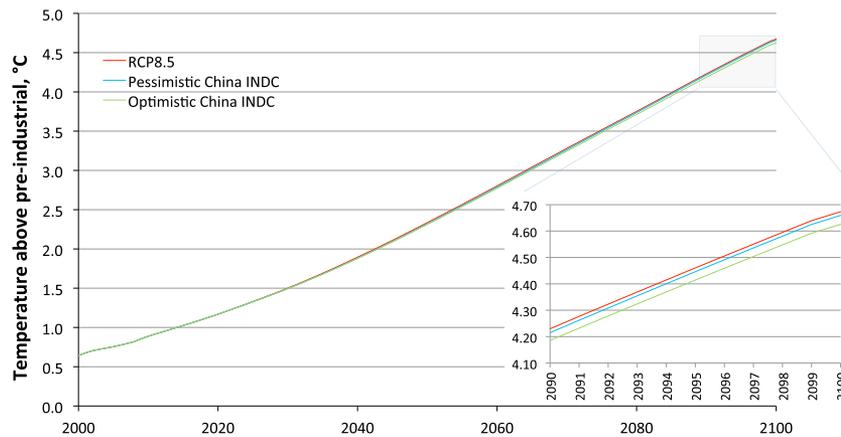
Taking the larger estimate of Boyd, Turner and Ward (2015), they find that the EU, the US and China contributes

Figure 9. China GHG emissions excluding land use, 1990–2100.



Note: Historic emissions 1990–2012 (CAIT WRI, 2015), baseline emissions 2005–2100 from Asia Modeling Exercise (Blanford, Rose and Tavoni, 2012) with optimistic and pessimistic China INDC (see text).

Figure 10. Global temperature anomaly from 2000–2100 with baseline RCP8.5, and optimistic and pessimistic China Paris promise (China INDC), run on MAGICC.



4–6.1Gt or 75–81 per cent. This fits well with the current article’s find of a 2030 reduction from the EU, the US and China of 5.3Gt CO₂-equivalent. Assuming that EU/US/China constitutes 78 per cent of the total reduction by 2030, we estimate that the rest of the world (RoW) will reduce emissions by a total of 1.5Gt, leading to a global emission reduction of 6.8Gt.

Taking the emission reductions from the US (Figure 3), the EU (Figure 7) and China (Figure 9) along with an emission reduction of 1.5Gt from all other countries, phased in linearly across 2016–2030, we obtain a global 2030 reduction of 6.2–6.8Gt (the smaller number is for the pessimistic scenario, where the US reductions maxes out already in 2025).

The optimistic scenario expects the 6.8Gt emission reduction to continue throughout the rest of the century, whereas the pessimistic scenario expects the EU, the US, China and the RoW to halve their emission reduction after their maximum every decade.

The impact of the total, global emission cuts implied by all the submitted INDCs as run on MAGGIC is shown in Fig-

ure 11. The temperature reduction by 2100 is 0.17°C in the optimistic scenario and 0.05°C in the pessimistic scenario, with an average of 0.11°C.

Conclusions

Based on climate model simulations, the emission cuts that have been proposed by the US, the EU, China and the RoW will reduce temperature increases by the end of the century, but almost all of the expected warming will still take place by 2100.

Because the climate policy impacts from individual countries are almost additive, they can be almost perfectly partitioned as is evidenced in Table 1. This shows that in the optimistic case, the EU and China each reduce mean global temperature by 2100 of about 0.05°C, and the US and the RoW each reducing a bit more than 0.03°C.

As Wigley (1998) found for the Kyoto Protocol, the emissions reductions promised until 2030 will do little to stabilize the climate and their impact will be undetectable for

Figure 11. Global temperature anomaly from 2000–2100, from baseline RCP8.5, and optimistic and pessimistic global Paris promises (Global INDCs) (see text), run on MAGICC.

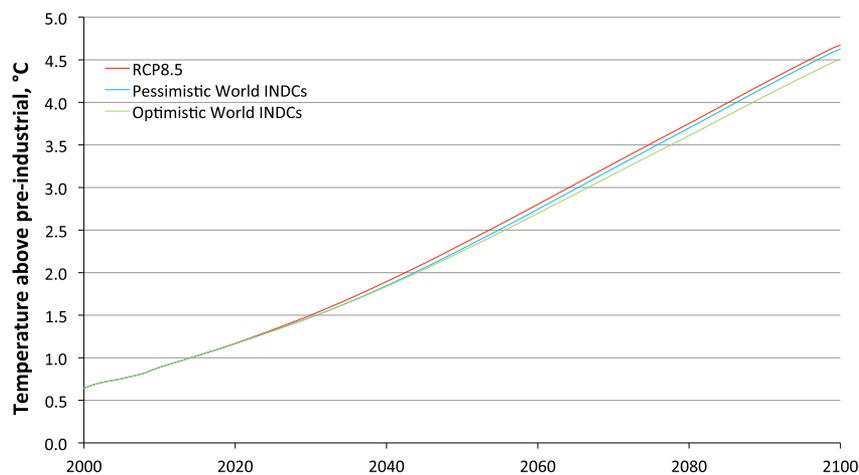


Table 1. Impact of climate policies, optimistic and pessimistic, for RCP8.5, using MAGICC, summary of finds described throughout the text

Change in temperature		
°C year 2100	Pessimistic	Optimistic
US INDC	0.008	0.031
US CPP	0.004	0.013
EU INDC	0.017	0.053
EU 2020	0.007	0.026
China INDC	0.014	0.048
RoW INDC	0.009	0.036
Global INDCs	0.048	0.170

many decades. This clearly indicates that if we want to reduce climate impacts significantly, we will have to find better ways than the ones currently proposed.

Notes

1. Searched topic for 'temperature reduction EU 2020 climate policy' and similar for 'EU 2030 climate policy', 'US Clean Power Plan', 'US 2025 emissions reduction' and 'China peak emissions,' which gave no relevant papers.
2. https://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch8s8-8-2.html, http://unfccc.int/adaptation/nairobi_work_programme/knowledge_resources_and_publications/items/5430.php, http://ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_summary-for-policy-makers.pdf [Accessed 9 August 2015].
3. <http://www2.epa.gov/cleanpowerplan/clean-power-plan-existing-power-plants>, <http://www.epa.gov/airquality/cpp/fs-cpp-by-the-numbers.pdf> [Accessed 11 August 2015].
4. Using EIA's 2015 Annual Energy Outlook data for 2015.
5. P. 26: 'As noted above, the AEO2015 cases do not assume implementation of EPA's proposed Clean Power Plan or other actions beyond current policies to limit or reduce CO₂ emissions.'
6. http://ec.europa.eu/clima/policies/strategies/2020/index_en.htm [Accessed 3 September 2015].
7. Notice that only two of the 14 scenarios continue from 2060–2100, so this part is less robust. Since we only look at the difference, this matters little.
8. http://ec.europa.eu/clima/news/articles/news_2014102401_en.htm [Accessed 21 August 2015].

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Figure S1. Global CO₂-equivalent emissions from 1990–2012, along with RCP2.6, RPC4.5, RCP6 and RCP8.5, 2005–2100. Included are also the 25 scenarios used here from EMF 27 and AME, along with their median (thick black).

Figure S2. Temperature difference between global policy and RCP8.5 for all possible climate sensitivity options in MAGICC for climate model (GISS, GFDL, MIRO etc.) and carbon cycle (Bern, Climber, Hadley etc.).

Figure S3. Annual global emissions, RCP8.5, the optimistic global INDC policy, optimistic extended global INDC assuming constant emission reduction rate forever, and a constant cap of global emissions at 2016 level.

Figure S4. Global temperature anomaly from 2000–2100, with baseline RCP8.5, optimistic global INDC policy, optimistic global INDC emission reduction rate extended forever and emissions held constant at 2016-level, run on MAGICC.

Table S1. Sensitivity of impact of climate policies, from RCP8.5 and RCP6

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