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The Impact of U.S. Re-engagement in Climate on the Paris Targets

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Abstract The Paris Agreement seeks to combine international efforts to keep global temperature increase to well-below 2°C. Whilst current ambitions in many signatories are insufficient to achieve this goal, optimism prevailed in the second half of 2020. Not only did several major emitters announce net-zero mitigation targets around mid-century, but the new Biden Administration immediately announced the U.S.'s re-entry into Paris and a net-zero goal for 2050. U.S. federal re-engagement in climate action could have a considerable impact on its national greenhouse gas emissions pathway, by significantly augmenting existing state-level actions. Combined with U.S. re-entry in the Paris Agreement, this could also serve as a stimulus to enhance ambitions in other countries. A critical question then becomes what such U.S. re-engagement, through both national and international channels, would have on the global picture. This commentary explores precisely this question, by using an integrated assessment model to assess U.S. national emissions, global emissions, and end-of-century temperatures in five scenarios combining different climate ambition levels in both the U.S. and the rest of the world. Our analyses finds that ambitious climate leadership by the Biden Administration on top of enhanced climate commitments by other the major economies could potentially be the trigger for the world to fulfill the temperature goal of the Paris Agreement.

Key Points:

- Enhanced climate pledges by major regions outside the U.S. have brought the Paris temperature targets within a realistic reach
- Compared to current climate action by states, cities and businesses, U.S. nationwide climate action avoids 0.03°C–0.09°C of global warming
- Ambitious climate leadership by the Biden Administration could potentially be the trigger for the world to fulfill the Paris temperature goal

Supporting Information:

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

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1. Introduction

Climate change is a global challenge requiring ambitious action by all the world's countries. The Paris Agreement is meant to bind together international efforts to reduce temperature increase to well-below 2°C in comparison to pre-industrial levels and pursue efforts to limit temperature increase to 1.5°C. Insufficient ambition to achieve this goal is however pervasive across the signatories of the Paris Agreement–the Nationally Determined Contributions (NDCs), put forward in 2015, set the world on a path that is, unlikely to limit global temperature increase to well-below 2°C (Climate Action Tracker, 2020; Fawcett et al., 2015; Rogelj et al., 2016), let alone 1.5°C. New NDCs will be put forward soon, presenting an opportunity to ratchet ambition and actions upwards.

In the second half of 2020, several major emitters set the tone with enhanced mitigation targets: the E.U. stated that it will reduce greenhouse gas (GHG) emissions in 2030 by 55% compared to 1990 instead of its initial reduction target of 40%; China pledged to become carbon-neutral before 2060, a timing that could be compatible with 1.5°C consistent global emission pathways (Robiou du Pont et al., 2016). Japan, South-Korea, the United Kingdom, and Canada also put forward net-zero goals for 2050 (Climate Action Tracker, 2020).

During the Trump Administration, the U.S. remained on the sidelines as other countries took leadership. More broadly, the stance of the U.S. federal government on climate change has been inconsistent over the last three decades and characterized by partisan polarization on environmental policy (Dunlap et al., 2016). Yet the U.S. plays a critical role in international climate ambition. The U.S. is the world's largest economy and second-largest GHG emitter, accounting for 12% of global GHG emissions in 2017 (Climate Action Tracker, 2020). Equally importantly, U.S. leadership has had an important influence on climate negotiations

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and the actions of other countries. Indeed, U.S. leadership was crucial to the successful adoption of the Paris Agreement (Parker & Karlsson, 2018). This Policy Forum explores the impact of renewed U.S. engagement on global emissions and temperatures.

The absence of recent U.S. federal engagement during the Trump Administration does not imply an absence of climate action in the U.S. in the Trump-era. After the Trump Administration announced the U.S.'s planned withdrawal from the Paris Agreement in 2017, multiple U.S. states, cities, businesses and other organizations committed, or enhanced their commitments, to reduce GHG emissions in accordance with the goals of the Paris Agreement. Even in the absence of federal engagement, these non-federal commitments on top of ongoing technology-driven trends are projected to reduce emissions in 2030 relative to 2005 (Hultman et al., 2020). While this reduction is inconsistent with most pathways to limit global temperature increase to well below 2°C (Robiou du Pont et al., 2016), any analysis of U.S. engagement must nonetheless acknowledge this evolving context of U.S. climate action.

In January 2021, the incoming Biden administration re-entered the Paris Agreement and announced the goals to reach net-zero economy-wide emissions by 2050 and net-zero power sector emissions by 2035. In April 2021, this was followed by the announcement of an updated NDC target to reduce economy-wide emissions by 50%–52% by 2030 (White House, 2021a, 2021b, 2021c, 2021d). Along with updated pledges from other major emitters, fulfilling the new U.S. commitment would not only directly reduce global GHG reductions; it could also be an impetus for other countries around the world to enhance their 2030 climate pledges. To this end, the Biden Administration has been actively involved in negotiations with other parties to encourage NDC enhancements by other parties ahead of the COP 2021 in Glasgow (Department of State, 2021a, 2021b; White House, 2021a, 2021b, 2021c, 2021d), with several new NDC enhancements ready announced at the 2021 Leaders' Climate Summit (Fransen et al., 2021). There is still uncertainty, however, about how much the newly elected administration and the thinnest of majorities in the U.S. Congress will be capable of accelerating U.S. climate action and whether U.S. reengagement is sufficiently credible to influence other countries' commitments.

In this commentary we explore feasible combinations of sectoral energy and climate policies in U.S. states (Hultman et al., 2020), and climate pledges in other regions, to understand the direct effect of U.S. ambition on emissions and the potential, indirect climate leadership implications. We extrapolate state- and country-specific climate "effort" in climate policies and pledges for 2030 to estimate emissions levels in 2050 and explore a range of temperature intervals for 2100. The scenarios shed light on the extent to which global climate ambitions in the coming years might affect long-term temperature outcomes, with a special focus on the expected impact of a shift in U.S. ambition.

1.1. Emission Pathways in the U.S. and the Rest of the World

To develop the emission pathways for the U.S. and the rest of the world (RoW), we use a global integrated assessment model (IAM) with disaggregated state-level information for the U.S. (GCAM-USA [Iyer et al., 2017]). We incorporate climate policy targets in the U.S. and stated GHG reduction targets in RoW up to 2030. Combined with an updated set of socio- and techno-economic assumptions (see Section 1c of the Supplementary Material (SM)), these 2030 targets are translated to a measure of climate change mitigation "effort," represented in the model by state- and region-specific carbon prices.

Mitigation efforts up to 2030 will likely reveal much about what happens after 2030 and the chance to limit warming to well below 2°C: from a legislative perspective it is easier to incrementally increase the ambition in policies after 2030 than to put new stringent policies in place (Pahle et al., 2018), while path-dependency in both technology and behavior facilitate the continuation of earlier efforts (Acemoglu et al., 2012). Therefore, both for individual states in the U.S. and countries/regions outside the U.S., we linearly extrapolated state- and region-specific carbon prices from 2020–30 to 2050 to project CO_2 emissions in 2050 as a function of policy ambition in 2030. In other words, for all individual U.S. states and regions outside the U.S., emissions in 2050 are projected based on stated ambitions up to 2030.

The policy scenarios applied to U.S. states through 2030 stem from pre-identified pathways (Hultman et al., 2020). The first scenario, "US Current Measures by 2020" (*USCurM2020*), represents all climate measures by federal and non-federal commitments by states, cities, and businesses, together representing 71% of

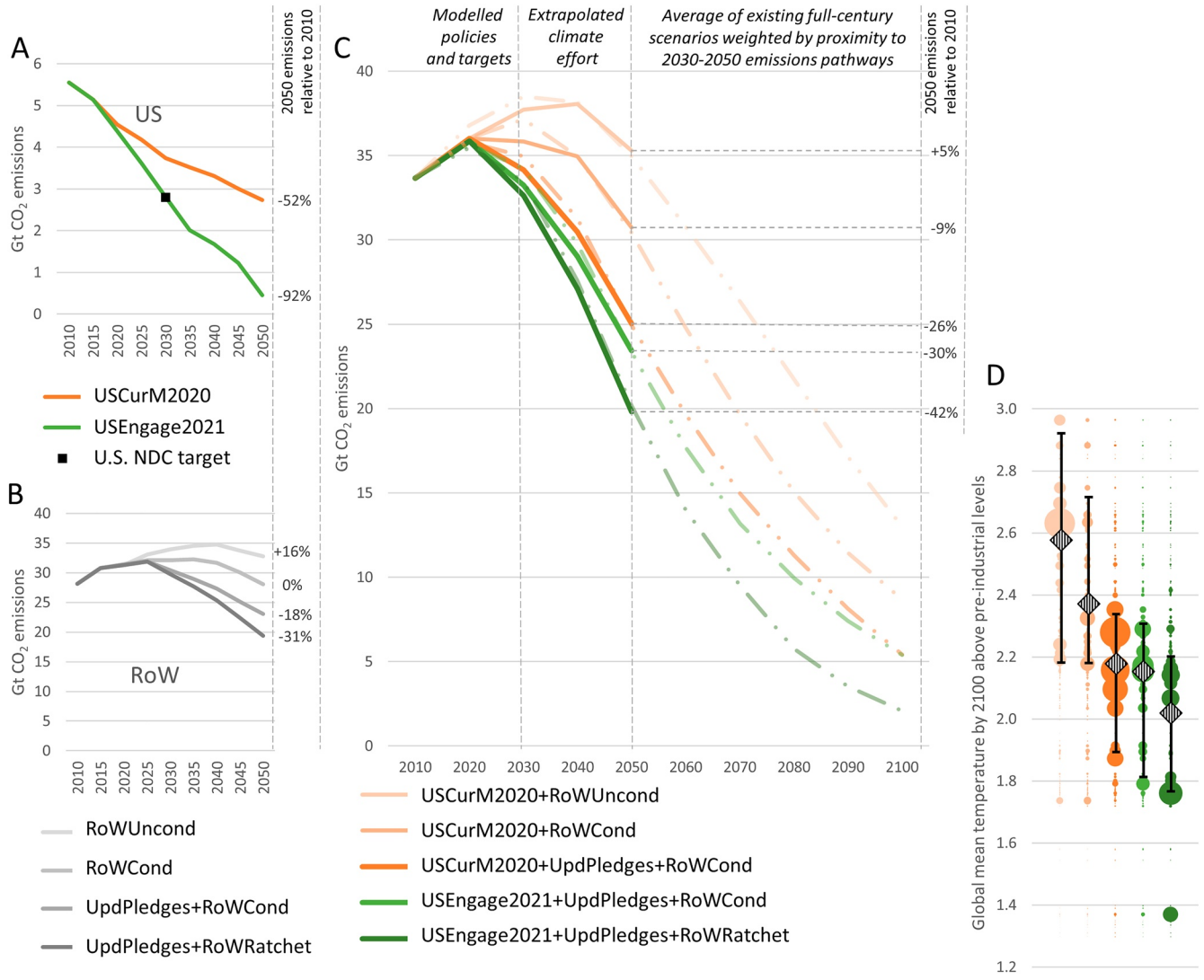

Figure 1. Panel A shows the CO_2 emissions of two U.S. scenarios, panel B the CO_2 emissions of four RoW scenario (See Section 3 in the SM for more detailed scenario outcomes). Panel C shows the combined scenarios until 2050 (see Table 1 for scenario definitions) and an average of existing full-century scenarios, weighted by their proximity to the modeled 2030–2050 CO_2 emission pathways. Panel D shows the range of end-of-century temperature outcomes from those existing scenarios, where the bubble size reflects the probability of each temperature outcome (based on the proximity to the 2030–2050 emission pathways), the striped rhombuses the weighted average of temperature outcomes, and the error bars representing the 90% confidence interval of all scenarios within a 3-Gt average range to the modeled 2030–2050 emission pathways. See Section 4 in the SM for more details.

GDP, 68% of population and 51% of GHG emissions in the U.S. To reflect the situation before federal re-engagement, only measures in place by 2020 are included in this scenario. The "U.S. Federal Re-engagement in 2021" (*USEngage2021*) scenario reflects a reasonable representation of energy and climate policies in line with the updated U.S. NDC target of 50%–52% emission reductions in 2030 relative to 2005. Since policies are updated continuously, we apply a pre-published representation of how federal and state-specific policies may be enhanced to reach this target (Hultman et al., 2020). For both U.S. scenarios, all policies have been scaled to the state level, correcting for potential overlapping between, for example, city, state and federal policies. Section S2a and Table S3 in the SM provide details on the U.S. energy and climate policies applied for these two scenarios.

Panel A in Figure 1 shows the U.S. emission trajectories of these two scenarios based on extrapolated state-specific policy effort until 2050. In terms of CO_2 emissions from energy and industry, the scenario projecting the impact from "U.S. Federal Re-engagement in 2021" is compatible with the updated NDC

Table 1
Description and Rationale of Scenarios

Scenario	Details	Rationale
USCurM2020 + RoWUncond	No effective federal U.S. re-engagement + Lowest level of original NDC ambition by other countries	Low-ambition interpretation of initial NDCs
USCurM2020 + RoWCond	No effective federal U.S. re-engagement + Highest level of original NDC ambition by other countries	High-ambition interpretation of initial NDCs
USCurM2020 + UpdPledges + RoWCond	As above but with ratcheted 2030 targets consistent with new 2050/2060 net-zero targets stated in 2020 pledges.	High-ambition interpretation of initial NDCs with increasing pledged ambition by major countries except the US
USEngage2021 + UpdPledges + RoWCond	As above but with effective federal U.S. re-engagement on top of non-federal action	Exploration of marginal impact of U.S. federal re-engagement action ***without*** consequential impact on RoW regions.
USEngage2021 + UpdPledges + RoWRatchet	As above, but with regions in RoW ratcheting their NDCs in line with a 2°C pathway	Exploration of marginal impact of RoW regions enhancing their ambition in response to U.S. Federal re-engagement.

Note. *USCurM2020*: U.S. Current Measures in 2020 (Hultman et al., 2020); *USEngage2021*: U.S. Federal Re-engagement in 2021 (Hultman et al., 2020) (called "Comprehensive" in reference); *RoWUncond*: Unconditional (developing countries) and low-range (for countries that give a GHG reduction range) NDC targets in the rest of the world (Fawcett et al., 2015); *RoWCond*: Conditional (developing countries) and high-range (for countries that give a GHG reduction range) NDC targets in the rest of the world (Fawcett et al., 2015); *RoWRatchet*: Ratcheted NDC targets to levels consistent with a 2°C future (or conditional/high-range NDCs if these are already sufficient) (Robiou du Pont et al., 2016); *UpdPledges*: Updated climate action pledges during 2020 (before U.S. elections) by the E.U., China, Japan, and South Korea. "RoWRatchet" NDC targets for these countries are used.

target of 50%–52% emission reductions in 2030 relative to 2005, while the scenario projecting "Current Measures in 2020" comes short of that target. Extrapolating federal, state, city and utility ambition to 2050 would bring CO_2 emissions from energy and industrial processes close to zero by mid-century in the federal re-engagement scenario.

The GHG reduction targets for 2030 outside the U.S. are meant to cover a range of global climate ambition. We explore four scenarios. The first two, with unconditional NDCs from developing countries and lower-range emission intensity reduction targets in the case of China, India, and others (*RoWUncond*) and conditional NDCs from developing countries and higher-range reduction targets for China, India and others (*RoWCond*) represent the range of climate ambition from the first round of NDCs at the onset of the Paris Agreement in 2015. The third scenario translates the updated pledges from the EU, China, Japan, and South-Korea that pre-dated the enhanced U.S. pledge to enhanced 2030 emission reduction targets, and adds these to the set of conditional NDCs in other RoW regions (*UpdPledges + RoWCond*). In the fourth scenario, apart from the improved targets in the E.U., China, Japan, and South-Korea, all regions with 2030 NDC targets inconsistent with 2°C pathways enhance their 2030 targets in line with existing 2°C compliant scenarios (Robiou du Pont et al., 2016), or remain with their Conditional/higher-range NDC target if that is sufficient (*UpdPledges + RoWRatchet*). The enhanced 2°C compatible NDC targets in the third and fourth scenario are calculated by taking the country-specific relative emission reduction from 2025 to 2030 from the average of five equity approaches of how the required 2°C-compatible emission abatement is divided between countries (Robiou du Pont et al., 2016) (implicitly assuming that the impact of any increase in ambition on emissions will only be visible after 2025). See Section 2 of the SM for more details. Panel B in Figure 1 shows these 4 emission pathways based on extrapolated region-specific mitigation effort until 2050.

1.2. Global Emission Pathways and Temperature Outcomes

Five global scenarios illustrate the impact of U.S. re-engagement relative to the impact of enhanced ambition in other major global emitters. Table 1 explains the details and rationale of these five combined scenarios, panel C of Figure 1 shows global CO_2 emissions in each of those 5 scenarios, and panel D of Figure 1 shows the range of end-of-century temperature outcomes obtained by comparing our modeled 2030–2050 pathways to a large set of existing full-century scenarios (see Section 4 of the SM for details).

In line with earlier literature (Climate Action Tracker, 2020; Fawcett et al., 2015; Rogelj et al., 2016), these scenarios show that current NDC targets will likely lead to global CO_2 emissions in 2050 similar to 2010 levels, and do not set the U.S. on a path that is, consistent with the Paris goals, but would end up with a likely end-of-century temperature increase of ~2.2°C–2.9°C (with the range reflecting the uncertainty in post-2050 global CO_2 mitigation efforts and mitigation of non-CO_2 GHGs over the course of the whole century). The existing net-zero pledges from the EU, China, Japan and South-Korea over the course of 2020 can be seen as independent from the level of ambition in the U.S. If met, these updated pledges alone will yield ~17% lower global CO_2 emissions by 2050 and assure that end-of-century temperature will likely stay below 2.4°C.

If the Biden Administration succeeds in implementing the required policies that also set the U.S. on a sustained path toward net-zero emissions by 2050, global CO_2 emissions in 2050 can be reduced by another 4% and likely global end-of-century warming drops to ~1.8°C–2.3°C. Despite the projection that U.S. emissions will keep going down even in the absence of federal engagement, due to non-federal climate action on the one hand (Hultman et al., 2020) and the irreversible economic case for renewable energy on the other hand (Obama, 2017), the direct temperature impact of federal U.S. re-engagement from 2021 onwards is still expected to be non-trivial, about 0.03°C–0.09°C beyond what states, cities, and businesses might achieve alone, an impact that can be crucial for achieving Paris goals and avoiding climate tipping points (Lenton et al., 2019).

Despite the enhanced climate pledges from important "early movers" like the EU, China, Japan and South-Korea and potentially the U.S., there are still several countries whose targets are not in line with (most) 2°C compatible pathways (Robiou du Pont et al., 2016; Roelfsema et al., 2020) and that have not updated their initial NDCs. An essential question is therefore whether the leadership of the early movers can compel these remaining countries to increase their ambition and action. If these countries enhance their climate pledges in line with the "early movers" and ratchet their NDC for 2030 to be compatible with these enhanced pledges, global CO_2 emissions in 2050 are projected to be around 20 Gt, a 12% decrease relative to a scenario where the U.S. improves its ambition on top of updated pledges by the E.U., China, Japan, South-Korea. Such a scenario sets the world on a realistic path to keep end-of-century temperatures below 2°C.

There are good reasons why active engagement by the U.S., on top of already strong ambition by the EU and China, can trigger other countries to enhance their climate pledges as well. First, since the Paris targets are set to reduce the risk for dangerous climate tipping points (Lenton et al., 2019), the probability that each incremental step in climate action limits warming to well below 2°C is larger if at least all of the world's largest emitters (China, U.S. and E.U.) also act accordingly and, therefore, other countries will have a greater sense that their efforts will be contributing to an achievable goal with larger emission cuts in the U.S.. Second, climate action will likely become more attractive from an economic point of view if more countries participate, due to market forces, increased innovation toward clean technologies, and economics of scale (Acemoglu et al., 2012). As the largest investor in innovation globally, active climate action in the U.S. will likely improve the economic attractiveness of mitigation (Sanderson & Knutti, 2016). Increased international climate financing contributions from the U.S. will enable further emission reductions in developing countries (Fransen et al., 2021). Finally, there is a fair degree of reciprocity in climate negotiations (Sælen et al., 2020). International environmental agreements may be self-reinforcing, since it is in the own interest for each country to show positive reciprocity toward an increase of ambition by other countries as long as the perceived global benefits of abatement outweigh the costs (Barrett, 1994; Kopp & Mignone, 2013; Kotchen, 2018), implying a positive impact of U.S. climate action on ambitions elsewhere. Positive reciprocity toward other countries' ambition was one of the key ingredients to the relative success of the Paris Agreement in 2015 (Bodansky, 2016). For each ton of committed CO_2 abatement in the initial U.S. NDC, 6.1–6.8 tons of emission reductions were committed by other countries (Houser & Larsen, 2021). Building upon this potential power of positive reciprocity, the most optimistic scenario in this letter assumes that each pledged ton of emission reduction in the U.S. by 2030 (beyond emission levels with "current measures in 2020") is met by 2.3 of emission reductions by other countries (beyond emission pathways based on initial–high ambition–NDCs) and extrapolating such improved ambition worldwide toward 2050, the multiplier would

be 4.9. Pledged ambitions by the E.U., China, Japan, and South-Korea that pre-dated the U.S. ambition improvement already deliver more than half of those tons.

The improved climate ambition of key actors over the course of 2020 has made global climate action brighter than at any point since the signing of the Paris Agreement, reducing the gap between Paris ambitions and Paris targets. Importantly, the Paris Agreement has survived the temporary withdrawal by the U.S., the world's biggest economy and second-biggest emitter, an event that brought into question global climate cooperation and the achievability of the 2°C and 1.5°C goals (Pickering et al., 2018; Sanderson & Knutti, 2016). While the combination of continuously declining costs for renewable energy and climate action in a coalition of states, cities, and businesses throughout the U.S. ensures emissions will decrease even in the absence of federal engagement, ambitious climate leadership by the Biden Administration on top of already ambitious leadership by other major players like the E.U. and China could potentially be the trigger to get the world on a path to limit warming to well below 2°C. The mix of domestic executive orders (see Table S8 in SM) and foreign policy (Department of State, 2021a, 2021b; White House, 2021a, 2021b, 2021c, 2021d) in the first six months of the Biden Administration reveal that they hope to quickly put the U.S. on a net zero pathway and reassert climate leadership at the international stage. The value of U.S. climate engagement and action goes well beyond its direct emissions; a return to its historical leadership position has an outsized potential to drive down global emissions.

Data Availability Statement

The input and output data of the scenarios in this paper is available through Zenodo (https://zenodo.org/communities/paris-reinforce/), and will be available in the IPCC AR6 scenario database. These data can also be consulted in the Supplementary Information of this paper.

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