Blueprint 2030:

An All-In Climate Strategy for Faster, More Durable Emissions Reductions

Technical Appendix

AMERICA IS ALL IN

INTRODUCTION TO ANALYTICAL APPROACH

This document describes the analytical approach underpinning the economy-wide emissions results and associated package of policies and climate actions presented in the America Is All In report *"Blueprint 2030: An All-In Climate Strategy for Faster, More Durable Emissions Reductions"*.

The overall analytic approach featured two primary components:

1. **Scenario Development and Emissions Impact Modeling,** including:

    a. Development of a **Policy Scenario** — a package of key policies and climate actions across all major emissions sectors that will meet or exceed U.S. climate goals; and

    b. Development and implementation of a **Modeled Scenari**o — a simulated representation of economy-wide U.S. emissions that reflects the effects of this package of key policies and climate actions.

2. **A Footprint Analysis** highlighting the scale of coalitions committed to climate actions in the U.S. in terms of their share of GDP, emissions, and population, which was developed as a stand-alone element unrelated to the scenario development and emissions impact modeling process.

The **Policy Scenario** was developed under the assumption that leaders across all levels of government work together to implement a suite of new measures to decarbonize the economy. The result is a framework that maps out key policy drivers and climate actions by the federal government, state and local governments, and businesses and institutions that will reduce U.S. emissions by 50% or more by 2030. More details on the development of the policy scenario, as well as a full mapping of the key policy drivers and climate actions, can be found in the ***Overview of the "All In" Policy Scenario and Framework*** section of this appendix.

The framework from the policy scenario was then used as the basis for the **Modeled Scenario**, which was implemented using a combination of bottom-up and top-down analytic tools. Ultimately, the purpose of the modeled scenario was to validate the primary policy drivers in the framework, providing a quantitative estimate of their combined impact on economy-wide emissions. By design, the modeling captures only a subset of actions from the policy framework that were assumed to be most critical for evaluating national emissions impacts. More details on climate policies included in the scenario and how they were modeled can be found in the ***Implementing the "All In" Modeled Scenario*** section of this appendix.

To quantify emissions impacts, bottom-up aggregation and data analysis were used to develop first-order estimates of the impacts of climate policies and actions in isolation or within specific sectors. GCAM-USA-AP, a version of the Global Change Assessment Model (GCAM) with a detailed representation of the U.S. energy system at the state level, was then used to simulate the impact of the policy framework on U.S. emissions. A 52% reduction in emissions from 2005 levels by 2030 is achieved in the modeled scenario. Final results, broken down by sector and greenhouse gas, are shown in Table 1 below. More information on methodology and tools used in this analysis can be found in ***Annex 1: Overview of Bottom-up Aggregation Methodology*** and ***Annex 2: Overview of GCAM-USA-AP*** at the end of this appendix.

TABLE 1 - RESULTS BY SECTOR FOR "ALL IN" MODELED SCENARIO

Sector/GHG	Emissions 2005 ($MMTCO_2e$)	Emissions 2019 ($MMTCO_2e$)	Emissions 2030 ($MMTCO_2e$)	Change from 2005 to 2030 ($MMTCO_2e$)	Change relative to 2005 (%)	Contribution to total reductions relative to 2005 (%)
Electricity CO_2	2416	1630	408	-2008	-83%	-30%
Transport CO_2	1866	1852	1141	-725	-39%	-11%
Industry CO_2	1199	1140	936	-263	-22%	-4%
Buildings CO_2	585	577	431	-154	-26%	-2%
Other CO_2	65	72	32	-33	-50%	0%
CH_4	707	809	602	-105	-15%	-2%
N_2O	432	458	450	18	4%	0%
F-Gases	147	185	107	-40	-27%	-1%
LULUCF	-815	-774	-913	-98	-12%	-1%
Net GHG Total	6604	5950	3195	-3409	-52%	-52%

In addition to the scenario development and emissions impact modeling process, a separate **footprint analysis** was also developed. The purpose of this analysis is to highlight the scale of coalitions committed to climate action in the U.S. in terms of their share of emissions, GDP and population. This analysis was done in parallel with—but is unrelated to—the scenario development process detailed in other sections of this appendix. Details on the methodology underlying the footprint analysis can be found in ***Annex 3: Overview of the Footprint Methodology***.

OVERVIEW OF THE "ALL IN" POLICY SCENARIO AND FRAMEWORK

This study relies on an ambitious policy framework, which was developed under the assumption that leaders across all levels of government work together to implement a suite of new measures to decarbonize the economy. The framework provides a comprehensive set of key policy drivers to reduce emissions by 50% or more by 2030 across all major emissions sectors, including specific actions to be taken by federal, state and local governments, and businesses and institutions.

Key steps in the development of the policy framework included:

- We reviewed and updated information on current high-impact policies and measures at the federal, state, city, and business level highlighted in *Accelerating America's Pledge* (2019).
- We reviewed external literature and peer modeling studies to supplement the list of key policies and drivers.
- We consulted with a wide range of external experts in key emissions sectors including power, transportation, buildings, industry, and natural and working lands to ensure that the policy framework was comprehensive and grounded in achievable—albeit ambitious—measures.
- Through economy-wide modeling and review of peer modeling studies, we validated the final set of policies to confirm alignment with a 50% by 2030 pathway.

Experts consulted in the development of the policy framework included researchers, technical staff, and other stakeholders in state and federal government, academia, and research NGOs. In total, input was received from 26 experts spanning these institutions. Literature consulted during this process included several peer studies on U.S. decarbonization potential and key policy drivers, including the University of Maryland *Charting an Ambitious U.S. NDC of 51% Reductions by 2030* study, the WRI *New Climate Federalism* study, and the National Academy of Sciences, Engineering, and Medicine *Accelerating Decarbonization of the U.S. Energy System* study.[1,2,3] Supplementary tables 1-5 show the finalized policy framework in detail, by emissions sector.

In summary, these tables represent a set of key policies and actions, by type of actor and by emissions sector, that would put the U.S. on a trajectory of 50% decarbonization or more by 2030 from 2005 levels. While broad in coverage, they do not represent the full universe of supporting policies that states, cities, and businesses may take, and many nuances are necessarily left out. This limitation notwithstanding, the overall framework represents a set of tangible policy goals and climate measures that can deliver a robust decarbonization agenda.

SUPPLEMENTARY TABLE 1. CLIMATE POLICIES AND ACTIONS INCLUDED IN POLICY FRAMEWORK - POWER SECTOR

Policy Sector	Federal	State	City	Business & Institution
Renewable/ Clean electricity	**Mandate:** • Clean electricity standard (80% of generation by 2030 and 100% by 2035) **Tax policy:** • Technology-neutral investment tax credit through 2030 at 30% of development costs • Technology-neutral production tax credit through 2030 at 2.5 cents/KWh **Direct investment and regulation:** • Infrastructure spending and FERC engagement targeting buildout of additional 10 GW of interregional transmission capacity by 2030 • Expansion of supply choice to commercial and industrial customers • Development of FERC wholesale market rules that support resource adequacy (reliable peaking capacity) in power systems with increasing shares of intermittent renewables	**Mandate:** • Accelerated clean electricity standards targeting 80% of electricity demand by 2030, with a minimum of 60% generated from renewable sources **Regulation:** • Development of regulations that support resource adequacy (reliable peaking capacity) in power systems with increasing shares of intermittent renewables	**Procurement target:** • City-wide clean electricity goals targeting 100% of demand by 2030.	**Procurement targets:** • Utility investment and planning to transition to 100% renewable power generation • 24/7/365 clean electricity targets for large corporate buyers
Nuclear	**Direct investment:** • Infrastructure spending to address costs, safety, and waste disposal to enable fleet retention Also see clean electricity standard.	**Incentives:** • ZEC policies and other subsidies to retain nuclear fleets in states with at-risk capacity	*No specific action or policy lever*	*No specific action or policy lever*
Coal	**Regulation:** • Federal standards, including use of existing Clean Air Act authorities, to ensure full phaseout of coal by 2030 Also see clean electricity standard.	**Regulation and incentives:** • Expansion of wholesale power markets and other policy mechanisms to drive accelerated coal retirement and ensure phaseout by 2030 • Coal securitization and other just transition policies put in place for affected workers and communities	*No specific action or policy lever beyond indirect impact of renewable procurement targets (see above)*	**Procurement targets:** • Utility resource planning to ensure full phase out of coal generation by 2030
Power sector GHG caps	*No specific action or policy lever* *Also see clean electricity standard.*	**Regulation and incentives:** • Expansion of state carbon pricing for the power sector through RGGI and/or integration of carbon pricing into wholesale markets	*No specific action or policy lever*	*No specific action or policy lever*
CCS	**Tax policy:** • 45Q tax credit of $85/ton through 2030	**Regulation and incentives:** • Expansion of investment in CCS infrastructure and geologic sequestration site identification	*No specific action or policy lever*	*No specific action or policy lever*
Gas	**Regulation:** • Federal standards to ensure 90% CCS is required for any new powerplants burning natural gas and delivering baseload power after 2025 • Federal standards and/or CES incentives to accelerate retirements of existing plants or conversion to low- or zero-carbon fuels (e.g., biogas or hydrogen) **Targeted investment:** • Some retention and investment in low capacity factor peaking plants - fueled by natural gas, biogas, or hydrogen - to ensure reliability	**Regulation and incentives:** • Expansion of wholesale markets and utilization of other policy mechanisms to constrain new gas plant builds and accelerate retirements or conversion to low- or zero-carbon fuels	*No specific action or policy lever*	*No specific action or policy lever*
Storage	**Incentives:** • Incentives for investment in storage paired with renewables, including PTC eligibility and extension through 2030 **Regulation:** • Development of FERC rules for cost recovery for storage investments that account for full suite of system benefits	**Incentives, regulation and mandates:** Expansion of state storage mandates for utilities, paired with incentives and regulatory reform to adequately value grid services and other benefits	No specific action or policy lever	**Investment and planning:** • Acceleration of utility investment in storage and integration into IRPs/long-term planning

SUPPLEMENTARY TABLE 2. CLIMATE POLICIES AND ACTIONS INCLUDED IN POLICY FRAMEWORK - TRANSPORTATION SECTOR

Policy Sector	Federal	State	City	Business & Institution
Fuel economy/ emissions standards	**Regulation:** • Fuel economy standards to yield LDV efficiency improvements of 3.7% per year through 2026, ramping up to 4.7% per year from 2027-2030. • Current HDV fuel economy standards; Phase two trailer rule that kicks in by 2023	**Regulation:** • Sate adoption of stringent standards to lock in high ambition improvements	*No specific action or policy lever*	**Leadership:** • Constructive auto manufacturer engagement on fuel economy standards
LDV electrification	**Procurement and investment:** • 100% federal fleet procurement of zero-emission LDVs by 2030 • Major infrastructure investment for 1 million new EV charging plugs **Tax policy and incentives:** • Federal scrappage program starting at $5,000 with incentive for high-mileage vehicles • Incentives for home charging so that 90% single-family and 15% multiple-dwelling units are charging ready by 2030 (on a path to 100% and 25%, respectively, by 2035) • Tax credit extension through 2030 at $7,500 minimum with no sunset	**Mandates:** • 100% ICE vehicle phasedown by 2035/ZEV mandates **Procurement and incentives:** • 100% procurement of zero-emission LDVs • Financial incentives for ZEVs and ZEV charging infrastructure **Regulation and innovation:** • Ride-hailing vehicles 90% ZEVs by 2030 • Building codes requiring new and renovated buildings to be ZEV charging ready • Development Public Utility Commission rules to support utility investment in ZEV infrastructure • Regional coordination of market-based policies and infrastructure planning	**Procurement and incentives:** • 100% public fleet conversion to electric/ZEV by 2030; Private fleet targets • Zero-emissions zones and expedited permitting for charging infrastructure	**Investment and innovation:** • Major auto manufacturers on-track to 100% ZEVs for new sales by 2035 • Ubiquitous workplace charging for all businesses that have parking lots. • Utility investment in ZEV infrastructure and rate structure to minimize costs
MDV/HDV electrification	**Procurement and investment:** • 100% of school bus fleet electrified, 30% of new sales for other segments by 2030 • 100% federal procurement of zero-emission light commercial trucks and buses by 2030 **Tax policy:** • New HDV tax credit equal to 10% of sales price up to $1,000,000	**Mandates and procurement:** • ZEV mandates for 30-50% new sales by 2030, depending on vehicle type, on a path to 100% by 2050 • 100% procurement of zero-emission light trucks and buses by 2030	**Procurement and incentives:** • 100% public fleet conversion to ZEV by 2030	**Investment and innovation:** • Automaker development of heavy-duty ZEV models, increasing availability and bringing down costs • Large fleet owner piloting of new models and conversion of fleets as technologies become more widely available
Uptake of low-carbon fuels	**Regulation and legislation:** • New, technology-neutral low carbon fuel program after current Renewable Fuel Standard mandates end in 2022 or new mandates to accelerate ZEVs and use of very-low carbon, waste-derived biofuels	**Regulation and legislation:** • Clean Fuel Standards targeting 20% reduction in average carbon intensity of fuels from 2020-2030 • Regional coordination of market-based policies and infrastructure planning	**Enabling policy and procurement:** • Policies to enable local low-carbon fuel production (e.g., zoning, organic waste bans from landfills) and partnership with producers to procure low-carbon fuels for municipal fleets	**Investment and procurement:** • Partnership with low-carbon fuel producers to invest in/ procure low-carbon fuels in vehicles that cannot yet be electrified
Cap-and-trade	*No specific policy lever or action*	**Regulation and legislation:** • State or regional cap-and-trade programs covering transportation	*No specific action or policy lever*	*No specific action or policy lever*
VMT reductions	**Investment and incentives:** • Double federal funding for public transit • $80 billion to modernize passenger and freight rail • Mandatory performance measure for highway CO_2 emissions for recipients of federal highway funding	**Regulation, zoning policy, and incentives:** • VMT reduction targets coupled with planning, zoning, and financial policies to achieve those targets • Use of community access to multiple modes of transportation as a performance metric in investment and policy decisions, including reliable public transit • Policies to mitigate VMT increases from ride-hailing services	**Urban planning, zoning policy, and incentives:** • VMT reductions through planning, low- and zero-emissions zones, decongestion pricing, other mechanisms	**Targets and leadership:** • Major shipper and carrier commitments to reduce truck miles per ton of freight

SUPPLEMENTARY TABLE 3. CLIMATE POLICIES AND ACTIONS INCLUDED IN POLICY FRAMEWORK - BUILDINGS SECTOR

Policy Sector	Federal	State	City	Business & Institution
Efficiency	**Standards and investment:** • Emissions-based building performance standard (BPS) for federal buildings, increasing the renovation rate to 3% per year with deep retrofits of 40% or more energy savings, serving as a model for state and city adoption • New investments to accelerate retrofits (e.g. $213 billion to retrofit more than 2 million homes) with a priority for LMI homes **Tax policy:** • Doubling of incentive rate for existing homes credit (25c) to 20% of eligible expenses for maximum cap of $1000 and extension to 2030 • Increase in new homes tax credit (45L) to $2,500 instead of $2,000 and extension to 2030 • Increase in incentive rate for commercial buildings tax deduction (179D) to $3 per sq. foot and extension to 2030	**Mandates:** • Heightened adoption of stringent EERS standards (targeting electricity savings of 2% per year or greater) • Incorporation of demand flexibility, such as Grid-interactive Efficient Buildings, in state utility strategic resource planning activities • Use of demand flexibility (active efficiency) in cost effectiveness tests for state utility programs **Building codes and standards:** • Adoption of emissions-based state building performance standards (BPS) targeting 3% annual deep renovation rate for state buildings and targets for ESPCs • Broader adoption of ZEB (zero-energy building) standards • Broader adoption of stringent appliance and lightbulb standards for non-preempted categories	**Stretch codes and standards:** • City stretch codes to accelerate energy savings and phase out gas appliances, targeting 11% energy savings over base code • Adoption of emissions-based city building performance standard (BPS) for city buildings	**Targets and leadership:** • Expanded voluntary target setting, benchmarking, and other voluntary measures • Participation in EPA EnergyStar and DOE Better Plants Challenge programs, EP100 • Inclusion of building decarbonization goals in public ESG commitments, including SBTs and Net Zero • Participation in Community Challenge programs
Electrification	**Mandates and standards:** • Adoption of stringent efficiency standards for appliances to enable zero-emissions buildings • Incorporation of energy-efficient electrification in model standard for federal buildings • Inclusion of electrification and demand flexibility in performance-based federal clean energy standard **Tax policy:** • Incentives for heat pump installation under energy efficient home improvement tax credit (e.g. $5,000 for air sourced and $10,000 for ground sourced) • Incentives for heat pump manufacturers (e.g. under sec. 45M)	**Mandates and building codes:** • Broader integration of fuel-neutral savings measures in EERS standards and ZEB (zero-energy building) standards with performance-based metrics • Incorporation of electrification and heating demand flexibility, such as connected heat pumps, into building codes • Bans on natural gas hookups for new buildings (residential and commercial)	**Stretch codes and standards:** • Acceleration of new standards to increase electrification and phase out gas appliances • Requirement of electrified or renewable heating in new and renovated buildings • Incorporation of electrification and heating demand flexibility, such as connected heating pumps, into local building codes	**Targets and leadership:** • Inclusion of building electrification goals in public ESG commitments, including SBTs and Net Zero • Participation in DOE programs to drive investment in electrification in commercial and institutional buildings

SUPPLEMENTARY TABLE 4. CLIMATE POLICIES AND ACTIONS INCLUDED IN POLICY FRAMEWORK - INDUSTRY SECTOR

Policy Sector	Federal	State	City	Business & Institution
CCS	**Tax Policy:** • 45Q tax credit for CCS projects increased to $85/ton through 2030	**Investment:** • Expansion of investment in CCS infrastructure and geologic sequestration site identification	*No specific policy lever or action*	**Innovation:** • Oil company implementation of CCS demonstration and pilot projects
Efficiency	**Procurement programs and certification:** • "Buy clean" policy supported and enabled by rigorous, clearly defined, and widely accepted product standards • EnergyStar efficiency certification program	**Mandates:** • Adoption of heightened Energy Efficiency Resource Standards (EERS) and International Organization for Standardization (ISO) 50001 energy management standards • Efficiency auditing program that mandates facility management and reporting of efficiency measures and metrics	**Targets:** • City-level efficiency targets including industrial facilities/buildings	**Targets and leadership:** • Partnership with regulatory authorities on best-practice adoption and development of advanced efficiency standards • Widespread adoption of benchmarking and transparency measures
Electrification	**Procurement program and certification:** • "Buy clean" policy to increase electrification, reducing combustion emissions from heating processes and onsite energy use • EnergyStar efficiency certification program that incorporates electrification	**Mandates**: • Mandate electrification of industrial processes where possible and practical in new facilities **Investment**: • State green bank financing and incentives for electrification of low-heat processes	*No specific policy lever or action*	**Targets and innovation:** • Electrification goals through retrofits and greenfield projects • Integrated resource plans identifying the need for transmission and distribution grid upgrades to meet additional load
Steel	**Standards and regulation:** • Federal "buy clean" standard that encourages increase in hydrogen use, electrification, CCS in steelmaking • A carbon border adjustment mechanism that incents further emissions intensity reductions in the sector	**Standards and building codes:** • State "buy clean" standards to encourage increase in hydrogen use, electrification, CCS • Program that mandates the adoption of best available technologies • Updated building codes to establish standards for embodied carbon in construction projects	**Standards and building codes:** • City "buy clean" standards to encourage increase in hydrogen use, electrification, CCS • Updated building codes to establish standards for embodied carbon in construction projects	**Targets:** • Enhanced targets by steel producers accounting for 80% of US raw steel production • Partnership with value chain stakeholders to aggressively develop and utilize GHG disclosure reporting mechanisms to increase efficiency of production • Incorporation of end-use considerations in services/business model, resulting in lower lifecycle GHGs
Cement	**Standards and regulation:** • "Buy clean" policy to increase efficiency of cement production by 22% by 2030 and encourage use of clean fuels and CCS • A carbon border adjustment mechanism to incent further emissions intensity reductions in the sector **Investment and innovation:** • Demonstration of negative emissions concrete in 5 facilities, combining CCS at cement kilns and synthetic aggregate made with CO_2 from DAC	**Standards and building codes:** • State "buy clean" standards to encourage use of clean fuels and CCS • Program that mandates the adoption of best available technologies • Updated building codes to establish standards for embodied carbon in construction projects	**Standards and building codes:** • City level "buy clean" initiatives • Updated building codes to establish standards for embodied carbon in construction projects	**Innovation and targets:** • Broader adoption of novel cement production practices, reaching 5% of market share by 2030 • Partnership with supply chain stakeholders to disclose GHG emissions • Incorporation of end-use considerations into services/business model
Hydrogen and other low-carbon fuels	**Tax policy:** • Hydrogen production tax credit and hydrogen investment tax credit **Regulation:** • Strengthened and updated RFS; low-carbon hydrogen standard **Investment:** • Funding for deployment and demonstration of early-stage technologies (e.g., H2-DRI steel plants) to accelerate commercialization	**Tax Policy and incentives:** • Hydrogen investment tax credit; hydrogen and hydrogen production equipment sales tax exemption; grants	*No specific policy lever or action*	**Leadership:** • Heavy industry commits to obtaining a growing share of high temperature heat from low carbon fuels

SUPPLEMENTARY TABLE 5. CLIMATE POLICIES AND ACTIONS INCLUDED IN POLICY FRAMEWORK - NON-CO_2S AND LULUCF SECTOR

Policy Sector	Federal	State	City	Business & Institution
Oil/Gas Fugitive Methane	**Regulation:** • Federal regulation, including through existing Clean Air Act authorities, to more comprehensively cap fugitive emissions, consistent with current leading state regulations covering new and existing sources **Investment:** • Major funding effort to plug orphaned and abandoned wells	**Regulation:** • Adoption of comprehensive measures capping leaks on new and existing sources, including requiring no bleed pneumatic controllers, frequent and extensive LDAR to look for leaks, and prohibition on venting and flaring	**Targets:** • Targets to ensure reduction of methane leakage from local distribution infrastructure	**Targets:** • Commitments from oil and gas majors to meaningfully reduce emissions through transparent platforms, e.g. Methane Challenge and One Future
HFCs	**Regulation:** • Expanded coverage of SNAP rules to all sources with viable low-GWP alternatives, following the lead of similar expansions in CA • More stringent leak management regulations to reduce emissions from existing sources • Ratification of Kigali Amendment	**Regulation:** • Expanded SNAP/phasedown policies covering additional sources to lock in reductions at the state level • Adoption of stringent RMP policies to accelerate reductions from existing sources	*No specific policy lever or action*	**Targets:** • Accelerated participation in EPA GreenChill, other corporate leadership initiatives to bolster best practice adoption and transparency
Other methane/N_2O (e.g.livestock, landfill, coal mining, nitric/adipic acid, croplands)	**Incentives and investment:** • Federal funding and incentives for livestock digesters, strategies to reduce enteric emissions, abandoned coal mine clean up, and sustainable agricultural practices to enable cost-effective abatement where viable	**Regulation:** • Adoption of common-sense regulations to cover additional CH_4 and N_2O sources from agriculture and industry **Incentives:** • Funding and incentives for biodigesters, strategies to reduce enteric emissions, and other sustainable agricultural practices	*No specific policy lever or action*	*No specific policy lever or action*
LULUCF	**Direct investment and incentives:** • Expanded federal investments in GHG quantification and monitoring • Increased funding for USDA programs that support practices that increase carbon sequestration in trees and soils on private land • Expanded investment in reforestation on federal land • Increased investment in wildfire risk mitigation	**Direct investment and incentives:** • Targeted programs and investments in reforestation, soil carbon sequestration, climate-friendly agricultural and forestry practices, and wildfire risk mitigation • Increased conservation and restoration practices on state and private land • Increased investment in GHG quantification and monitoring	**Targets and investment**: • Expanded urban forestry efforts in-line with current leading U.S. cities, targeting 40% tree canopy coverage and prioritizing low-income and vulnerable communities	**Leadership and investments:** • Increased leadership to source a greater percentage of agricultural and timber products from farms and forests that use climate-friendly management practices • Increased investments in land-based climate mitigation strategies

IMPLEMENTING THE "ALL IN" MODELED SCENARIO

OVERVIEW

To develop a modeled scenario informed by the above policy framework, we used bottom up aggregation tools and data analysis to evaluate and quantify impacts of policies and climate actions in isolation and within specific sectors. We then used this information in GCAM-USA-AP to estimate the economy-wide implications of these associated policies. The overall modeling approach used was consistent with previous analyses, including *Fulfilling America's Pledge (2018), Accelerating America's Pledge (2019),* and *An All-In Climate Strategy Can Cut U.S. Emissions by 50% by 2030 (2021)*. For a more detailed description of the aggregation methodology, please see the Accelerating America's Pledge Technical Appendix (2019) and Hultman, et al. research article (2020) and accompanying supplementary information.[4,5] Because of the complexity of the framework, and of modeling emissions a decade into the future, our estimated emissions reductions are only approximations. They are intended to provide confidence that the policy framework is likely to achieve reductions of 50% or more and not to provide a precise estimate of the emissions reductions from the policy framework.

IMPLEMENTATION OF POLICIES

The modeled scenario was produced by changing parameters in GCAM-USA-AP, either directly or based on information from bottom-up aggregation analysis. Modeling of each of the measures in the policy framework was beyond the scope of this study and not always necessary. We selected a subset of measures that could be effectively modeled and that were considered to be representative of the most impactful elements of the policy framework. Supplementary Table 6 describes how the policy framework was implemented in GCAM-USA-AP. An overview of the version of GCAM-USA-AP and the assumptions supporting this analysis are provided in Annex 2 of this Technical Appendix.

For a number of policy drivers included in the analysis, bottom-up aggregation was either not feasible or not required, and policies were directly implemented in GCAM-USA-AP. For example, while potentially driven by a number of bottom-up policy measures from utilities and states as well as consumer demand, a phaseout of coal power was modeled directly in GCAM-USA-AP by setting a national constraint on coal generation to reach zero by 2030.

By contrast, nuclear capacity retention is an example of a policy lever that was explicitly modeled using a more bottom-up approach. Nuclear power plants at risk of retirement before 2030 were identified on a state-by-state basis. A combination of state and federal measures were then evaluated and assumed to allow for approximately 17,000 MW of this otherwise at-risk nuclear capacity to remain online through 2030. In addition, it was assumed that Vogtle units 3&4 in Georgia, the only new nuclear plants currently scheduled to come online in the U.S., would begin operating at full capacity by 2030. This assessment was then translated to state-level capacity and generation values by year, which were integrated into GCAM-USA-AP.

In many cases, policies were excluded from the economy-wide modeling because they were assumed to be supportive of other policies already modeled, they had a negligible impact on 2030 emissions, and/or evaluating their impacts was beyond scope of this study and the tools employed. For example, policies associated with electricity transmission and storage were not explicitly modeled and were assumed, instead, to support clean energy deployment. As another example, emissions reductions from RGGI targets in the power sector were found to be already met or exceeded through the other power sector policies included in this study and therefore not explicitly modeled. Finally, policies related to hydrogen and other low-carbon fuels in the industry sector were considered to have only modest 2030 impact and were not modeled due to limitations with GCAM-USA-AP.

All policies explicitly included in the analysis were modeled at the state and/or national levels. City, business, and institution policies were generally assumed to be embedded within or supportive of the national and state policies and not explicitly modeled. However in some cases—where data and scope allowed for the evaluation of additional impact—actions on these smaller scales were also included. As an example, the impacts of renewable targets from states, cities, and electric power utilities were aggregated together at the state level, with city and utility targets being counted as additional where a higher

percentage of renewable generation was targeted. More details on specific policies included and aggregation approach can be found in **Table 6** and in ***Annex 1: Overview of Bottom-up Aggregation Methodology.***

RELATIONSHIP TO THE POLICY FRAMEWORK

As discussed above, the policy framework and the modeled scenario were mutually reinforcing components of this analysis. The policy framework was the basis for the modeling analysis and provides granular detail on the "playbook" of specific measures to be taken in order to deliver necessary emissions reductions. The modeling analysis served to validate the primary policy drivers within the framework in terms of impact and identify the sectors most critical to reduce emissions by 50-52% by 2030.

An important characteristic of the policy framework is that many of the policies overlap with one another and are supportive of one another. The duplication and interaction among policies increases the robustness and durability of the policy platform. If one actor proves to be less ambitious than hoped, others may pick up the slack. Conversely, the fact that one actor is moving on climate change increases the momentum for others to do the same. And frequently one actor needs another in order to interact to implement its policies. For example, effective subnational management of electricity systems is critical to support broader deployment of variable renewable electricity. From a modeling perspective, the overlap means that not every policy needs to be modeled to obtain an effective representation of the overall impact of the policy framework.

We would like to emphasize that the modeling of some policies is inevitably less nuanced than what is needed to occur in reality. For example, we modeled the retirement of all coal plants by 2030 and no new uncapped gas starting in 2025. However, from a cost effectiveness standpoint many of these coal plants could be retrofitted to burn gas, and existing gas plants could be retrofitted to capture carbon or to burn hydrogen. These types of retrofits were not included in our modeled scenario due to the limited scope of our study, though they very likely need to be considered in the implementation of gas- and coal- related policies. As such, the modeling portion of this study should not be mistaken as policy guidance.

Finally, we would like to note that the purpose of this analytical activity is to confirm the national effectiveness of the policy platform – its ability to ensure that the U.S. meets or exceeds its 50-52% commitment. This means that we modeled actions at the subnational scale only to the extent that doing so would help to confirm national goals. In some cases, we did not distinguish among states when implementing policies – for example, in implementing electric buses – because assessing the national impact did not require state-level precision. An important implication of this approach is that confidence in national results is higher than confidence in results for specific states or regions.

SUPPLEMENTARY TABLE 6. POLICIES AND CLIMATE ACTIONS INCLUDED IN THE MODELED SCENARIO

Sector	Modeled Policy/ Climate Action	Key Assumptions for "All In" Scenario	Implementation
Power	Renewable/ Clean electricity	**Federal mandate:** Federal clean electricity standard (CES) of 80% by 2030 and 100% by 2035	The federal CES was modeled through a combination of policy drivers described in greater detail in the rows below. Together, these policy drivers achieve clean electricity deployment equivalent to the CES.
		Federal tax policies: Federal production tax credit (PTC) for wind power is increased to 2.5 cents/KWh and the investment tax credit (ITC) for solar power is extended at 30% of development costs through 2030. Technology neutral credits were beyond the scope of this study and were not explicitly modeled.	The PTC was modeled by applying tax subsidies to the cost of wind technologies. The ITC was modeled by a reduction in investment cost of solar technologies.
		Federal grid investment and regulation: Expansion of transmission infrastructure and supply choice and development of wholesale market rules were assumed to be supportive of and embodied in clean energy deployment levels and were not explicitly modeled.	
		State mandates, city and utility procurement: RPS targets of at least 60% by 2030 for high ambition states and 50% for moderate ambition states are assumed. City- and utility-level goals were assumed to be supportive of these state-level targets and additional only in cases where a higher percentage is targeted.	Combined impact of subnational targets were aggregated together and implemented by setting a minimum % of total electricity load to be met by renewable generation at the grid region level.
	Nuclear	**Federal and state investment and incentives:** Through a combination of federal and state-level incentives and maintenance measures, 16,996 MW of at-risk nuclear capacity is retained through 2030, and Vogtle units 3&4 come online at full capacity.[6]	Nuclear generation was exogenously specified to reflect the operating units, resulting in 785 TWh of generation in 2030.
	Coal	**Federal and state regulations, utility procurement:** Federal standards ensure full phaseout of coal by 2030. Expansion of wholesale markets and coal securitization at the state level and utility procurement targets were assumed to be supportive of this phaseout and were not explicitly modeled.	A coal phaseout was modeled by setting a national constraint on coal power to reach zero by 2030, and by prohibiting the buildout of new coal plants in all states.
	Power sector GHG caps	**State regulations:** Emissions reductions consistent with current RGGI targets and proposed expansions at the state level were met or exceeded through modeling of other policies and therefore not explicitly modeled.	
	CCS	**Federal tax policy, state investment:** Federal 45Q tax credit of $85/ton is implemented through 2030. These policies are assumed to result in sequestration levels consistent with analyses by Rhodium Group and Edmonds et al.[7,8] State policies were assumed to be supportive of federal measures and were not explicitly modeled.	Federal 45Q tax credit for CCS projects was modeled by specifying gas CCS to reach 486 TWh, resulting in 140 $MTCO_2$ annual sequestration by 2030.
	Gas	**Federal and state regulations:** New baseload natural gas builds without at least 90% CCS are prohibited in all states. Retention and investment in low capacity factor peaking plants were assumed to be supportive of these measures and were not explicitly modeled.	Constraints on new gas generation were modeled by prohibiting natural gas plants without CCS starting in 2025.
	Storage	**Federal and state regulations and incentives, utility investment:** Storage targets, investment, and other grid storage policies were assumed to be supportive of renewable energy targets and were not explicitly modeled.	

SUPPLEMENTARY TABLE 6. POLICIES AND CLIMATE ACTIONS INCLUDED IN THE MODELED SCENARIO

Sector	Modeled Policy/ Climate Action	Key Assumptions for "All In" Scenario	Implementation
Transport	Fuel economy/ emissions standards	**Federal mandate:** Federal clean electricity standard (CES) of 80% by 2030 and 100% by 2035	Federal ICE GHG performance goals were modeled by improving state-level vehicle fuel efficiency by the same rate for all states so that nationally, fuel efficiency improves by 45% for new passenger cars and SUVs from 2020 to 2030.
	LDV electrification	**Federal, state, and corporate mandates, incentives, and commitments, city procurement:** Combined policies drive ZEV sales to two-thirds of the national LDV market by 2030 (consistent with NREL EFS High pathway).[9] Sustained scrappage policy through 2030 accelerates retirement of older, less efficient vehicles. Procurement targets at the city and corporate level were assumed to be supportive of ZEV sales rates at the state level.	Aggregated 2030 ZEV targets and incentives were implemented by specifying additional ZEV fleet necessary to meet targets at the state level. Federal policies to accelerate removal of old and inefficient vehicles were modeled by reducing the expected lifetime of vehicles manufactured prior to 2015, leading to the retirement of 90% of such vehicles by 2030.
	MDV/HDV electrification	**Federal, state, and corporate mandates, incentives, and commitments:** Combined policies drive ZEV sales to 50% of medium-duty and 30% of heavy-duty vehicle market by 2030 (consistent with CA Advanced Clean Trucks Rule and 15-state MOU commitment).[10] Corporate-level targets and investment were assumed to be supportive of federal and state targets.	2030 federal and state ZEV sales targets and incentives for MDVs and HDVs were modeled by exogenously specifying state-level electric truck deployment to reach 12% for MDVs and 9% for HDVs (total fleet).
		Federal, state and city procurement: Federal, state, and city-level procurement drives national ZEV sales rate for new buses to 100% by 2030. State and city measures were assumed to be supportive of this national sales rate.	Electrification of buses was modeled by raising the national level sales shares to achieve 100% electrification by 2030.
	Uptake of low-carbon fuels	**Federal and state regulations, local measures, and corporate investment:** Policies related to the uptake of low carbon fuels were beyond the scope of this study and were not explicitly modeled.	
	Cap-and-trade	**State regulations:** Emissions reductions consistent with current clean- and low-carbon fuel standards and proposed cap-and-invest programs at the state level were met or exceeded through modeling of other policies and therefore not explicitly modeled.	
	VMT reductions	**Federal investment, state and local planning, zoning, and incentives:** Combined policies lead to annual average per capita VMT reductions ranging from 0.5% to 1% in all states from 2025-2030 (consistent with current ambition in leading states). City-level measures were assumed to be supportive of state-level reductions.	Annual average per capita VMT reduction rates were implemented as state-level service demand reduction rates in the transport sector.
Buildings	Efficiency	**Federal and state mandates, building codes and incentives, city and corporate targets:** Combined measures drive improved efficiency in residential and commercial buildings, with state-level savings consistent with "high achievable" estimates from EPRI analysis. These values varied state-to-state, ranging from 0 to 2.7% annual savings from 2025 through 2030.[12] Leader states also achieve a minimum of 2% annual savings through EERS policies. City- and corporate-level targets were assumed to be supportive of state-level savings.	Combined energy efficiency targets and programs were modeled by reducing state-level building service demands, leading to national energy savings of 9.5% for residential buildings and 14.2% for commercial buildings by 2030.
	Electrification	**Federal and state mandates, building codes and incentives, city and corporate targets:** Combined measures drive new appliance sales to 100% electric across all states for residential and commercial building demand. Component-specific turnover rates and changes in energy demand associated with an all-electric sales by 2030 pathway were derived from EPS and applied to NREL's EFS reference case[13,14] City stretch codes and corporate targets were assumed to be supportive of state-level electrification rates.	Combined federal and state building policies were modeled by raising state-level consumer preferences for electric appliances to achieve 61% electrification by 2030.

SUPPLEMENTARY TABLE 6. POLICIES AND CLIMATE ACTIONS INCLUDED IN THE MODELED SCENARIO

Sector	Modeled Policy/ Climate Action	Key Assumptions for "All In" Scenario	Implementation
Industry	CCS	**Federal tax policy, state investment, corporate targets:** Federal 45Q tax credit of $85/ton is implemented through 2030. These measures are assumed to result in sequestration levels consistent with Rhodium Group analysis.[15] State investment and corporate targets were assumed to be supportive of federal measures.	Federal 45Q tax credit for CCS projects was modeled by exogenously specifying sequestration across various industrial sectors, resulting in 79 $MTCO_2$ annual sequestration by 2030.
	Efficiency	**Federal and state procurement and mandates, city and corporate targets:** Combined measures drive improved industrial energy savings, based on LBNL analysis of ISO 50001 standards[16] and "high achievable"potential from EPRI state-level analysis.[17] City and corporate targets were assumed to be supportive of state savings levels.	Combined efficiency policies were modeled by specifying state-level energy efficiency improvement rates in the industry sector aligned with EPRI and LBNL analysis, achieving national energy savings of 3.7% by 2030.
	Electrification	**Federal and state procurement and mandates, corporate targets:** Combined measures drive electrification of industrial energy use to be consistent with NREL's High/ Rapid 2050 electrification scenario.[18] Corporate targets were assumed to be supportive of state-level electrification levels.	Federal and state electrification measures were modeled by exogenously specifying electrification of industrial energy use to be in alignment with NREL's analysis, reaching 21.7% by 2030.
	Steel	**Federal, state and city standards and regulations, corporate targets:** Policies related to steel were assumed to be supportive of industry-wide efficiency and electrification policies and were not explicitly modeled.	
	Cement	**Federal, state and city standards and regulations, corporate targets:** Industry makes rapid progress switching away from coal and petcoke, incorporating higher shares of supplementary cementitious materials, and meeting demand using lower-GHG mixes. Federal "Buy Clean" programs reduce cement emissions by 22% by 2030, consistent with analyses from EFI, McKinsey and IEA[19,20,21]. State-, city- and corporate-level policies were assumed to be supportive of federal policies.	Reduced process emissions were modeled through reducing fossil fuel input by 22%.
	Hydrogen and other low-carbon fuels	**Federal and state tax policies and regulations, industry initiatives:** Policies related to hydrogen and other low-carbon fuels were expected to have negligible impact on industry emissions by 2030 and were not explicitly modeled due to limitations.	
Non-CO_2 emissions	Oil and gas methane	**Federal and state regulations, city and corporate targets:** Federal and state standards drive reduction in oil and gas methane leakage by 60% nationally by 2030, consistent with current best-in-class, comprehensive regulations under development.[22] Oil and gas production growth declines post-2025 due to reduced demand, consistent with IEA's Net Zero by 2050 scenario.[23] City- and corporate-level measures were assumed to be supportive of state-level reductions.	Federal and state-level policies to mitigate CH_4 emissions from oil and gas extraction were implemented by assuming a 60% emissions reduction from the baseline in 2030.
	HFCs	**Federal and state regulations:** National HFC phasedown is implemented consistent with the AIM Act. Leading cohort of states achieves additional reductions through more comprehensive measures including SNAP and RMP programs, reducing emissions up to 65% from baseline trajectory by 2030 (consistent with analysis and modeling results developed by CARB).[24]	Federal and state HFC phaseout policies were implemented by specifying state-level % reductions from the baseline scenario.
	Other Non-CO_2 categories	**Federal and state incentives and regulations:** Combined regulations on additional non-CO_2 emissions sources, investments in best-practice adoption, payments for ecosystem services, and other incentives allow for significant improvement in abatement of emissions from agriculture and industrial processes.	Other Non-CO_2 reductions were modeled by implementing marginal abatement cost curves for CH_4, N_2O, and HFCs emissions based on EPA MAC report and specifying emission prices of $50/$MTCO_2e$ in 2025 and $100/$MTCO_2e$ in 2030.

SUPPLEMENTARY TABLE 6. POLICIES AND CLIMATE ACTIONS INCLUDED IN THE MODELED SCENARIO

Sector	Modeled Policy/ Climate Action	Key Assumptions for "All In" Scenario	Implementation
LULUCF		**Federal, state, city, and corporate investment and incentives:** Combined reforestation, forest restocking, soil carbon, and other natural and working lands strategies allow for significant improvement in carbon sequestration levels by 2030, consistent with state-level sequestration potential estimates from Nature4Climate, derived in part from Fargione et al. (2018).[26,27] City and corporate measures were assumed to be supportive of state-level potential estimates.	2030 sequestration levels of \$10-\$50/ton CO_2 were implemented by state, based on historic and current state ambition. Impacts were aggregated together, yielding total national 2030 LULUCF emissions of -913 $MTCO_2e$ (up from present-day baseline derived from EPA Greenhouse Gas Inventory).[28]
Economy-wide GHG Targets		**State emissions targets:** The achievement of economy-wide GHG targets for leading cohort of states was implicitly assumed. Since these targets were generally found to be met or exceeded through the achievement of sector-specific policies elsewhere in this table, they were not modeled directly, with the exception of California.	State-level GHG targets were met or exceeded through the achievement of sector-specific policies and therefore not explicitly modeled. One exception is California, where a separate emission constraint was needed in addition to sectoral policies.

ANNEX 1: OVERVIEW OF BOTTOM-UP AGGREGATION METHODOLOGY

This analysis relies in part on a previously developed methodology for aggregating the impact of non-federal climate actions across state, city, and business actors. Impacts are quantified by sector and actor and aggregated to the state level, accounting for overlaps, before then being integrated with GCAM-USA-AP for simulation of full economy-wide impacts. A brief summary of the methodology is given below, followed by a table of key policies evaluated and underlying data sources (Supplementary Table 7). For a more detailed description of the aggregation methodology, please see the Accelerating America's Pledge Technical Appendix (2019)[29] and Hultman, et al. research article (2020) and accompanying supplementary information.[30]

The approach synthesizes current policies and commitments at multiple scales as well as the potential for accelerated and expanded policies. Non-federal entities implement emissions-related policies for many reasons, including cost savings, consumer benefits, health, economic growth, and climate. For simplicity, in this analysis we refer to any policy that reduces GHG emissions as a climate policy and overall categories of actions as policy sectors. The approach to quantifying the impact of city, state, and business actions was informed by existing protocols and methodologies such as the *Non-State and Subnational Action Guide* developed through the Initiative for Climate Action Transparency,[31] the Compact of Mayors Emission Scenario Model,[32] and the Greenhouse Gas Protocol Policy and Action Standard,[33] among others.

Overall, the bottom-up aggregation process can be summarized as follows:

1. Survey, at a minimum, all 50 states and the 285 most populous cities in the U.S.
2. Identify a subset of high-impact actions for inclusion in the analysis
3. Collect the necessary data to quantify each action
4. Estimate a reference "no policy" scenario for each actor and emissions sector through 2030
5. Calculate combined impacts for each actor level (e.g., cities and states) for a "current measures" scenario reflecting only on-the-books actions
6. Calculate combined impacts for each actor level (e.g., cities and states) for "enhanced" scenarios that assume additional policy ambition beyond present-day levels
7. Aggregate impacts within each sector to the state level, taking into account overlaps
8. Pass the information to GCAM-USA-AP

SUPPLEMENTARY TABLE 7. SUMMARY TABLE OF CLIMATE POLICIES AND ACTIONS INCLUDED IN AGGREGATION ANALYSIS AND KEY DATA SOURCES BY SECTOR:

Policy Sector	Key climate policies/actions evaluated	Key underlying data sources
Emissions Caps	State-level power sector emissions caps (RGGI); state-level economy-wide emissions caps	C2ES[34]; CARB[35]
Renewable electricity generation	State-level renewable portfolio standards and clean electricity standards; city-level renewable electricity targets; utility-level renewable electricity/emissions reduction targets	LBL[36]; EIA historic data[37]; Sierra Club[38]; DOE/NREL[39]
Oil and gas methane abatement	State-level regulations covering new and existing facilities; business-level reductions reported through EPA Natural Gas STAR	EDF[40]; EPA[41]
Nuclear fleet retention	State-level zero-emission generation incentives and other nuclear fleet retention measures	EIA[42]; UCS[43]
Vehicle electrification	State-level ZEV mandates; city-level fleet procurement targets	EIA[44,45]; NREL[46]; ACEEE[47]
Vehicle fuel economy/tailpipe emissions standards	State-level vehicle emissions standards	California Air Resources Board[48]; EDF[49]; ICCT[50]
VMT reduction	State-level VMT reduction targets; city-level VMT reduction targets	ACEEE[51]; FHWA[52]; DOE/NREL[53]
HFC phasedown	State-level SNAP and RMP policies; business-level reductions reported through EPA GreenChill program	EPA[54]; CARB[55]; WRI[56]
Energy efficiency	State-level EERS policies; State-level building code adoption; city-level energy savings targets; city-level building code adoption; industry energy management standards	ACEEE[57,58];EIA[59]; PNNL[60]; NEEP[61]; LBL[62]
Natural and working lands	State-level climate solutions such as natural forest management, optimal nutrient application, and the use of cover crops	Nature4Climate[63]

ANNEX 2: OVERVIEW OF GCAM-USA-AP

The estimates of economy-wide emissions reductions in this analysis are based on a version of the Global Change Analysis Model (GCAM) with a detailed representation of the U.S. energy system at the state level (GCAM-USA). We refer to the modified version of GCAM-USA used in this study as GCAM-USA-AP.

The global version of GCAM is an Integrated Assessment Model that represents the energy and economic systems for 32 geopolitical regions, including the United States. GCAM represents land use and agriculture in 384 land regions nested within 235 water basins. GCAM tracks emissions of a range of GHGs and air pollutants from energy, agriculture, land use, and other systems.

GCAM-USA is a version of GCAM that disaggregates the U.S. energy and economy components into 50 states and the District of Columbia while maintaining the same level of detail in the rest of the world and for water and land sectors. The energy system formulation in GCAM-USA consists of detailed representations of depletable primary sources such as coal, gas, oil and uranium, in addition to renewable resources such as bioenergy, hydropower, wind, and geothermal.

GCAM-USA also includes representations of the processes that transform these resources to final energy carriers, such as refining and electric power. These energy carriers, in turn, are used to deliver services to end users in the buildings, transportation, and industrial sectors. The electric power sector includes representations of a range of power generation technologies, including those fueled by fossil fuels, renewables, bioenergy, and nuclear power.

GCAM-USA is a market equilibrium model. The equilibrium in each period is solved by finding a set of market prices such that supplies and demands are equal to one another in all markets as the actors in the model adjust the quantities of the commodities they buy and sell. GCAM operates in 5-year time-increments, with each new period starting from the conditions that emerged in the last.

GCAM-USA-AP is based on the open-source release of GCAM-USA 5.3. GCAM-USA-AP has been modified for the purposes of this study to reflect the latest renewable energy costs and vehicle technology costs and alternative projections of key variables (e.g., fuel prices, economic growth). It is also calibrated to the latest non-CO_2 marginal abatement cost curves from the U.S. Environmental Protection Agency.[64]

Harmonization with EPA Inventories

GCAM independently builds up historical emissions from underlying activity level and emission factors. This creates differences with the U.S. EPA Inventory of Greenhouse Gas Emissions. To harmonize GCAM results to the EPA inventory, GCAM subsectors were first re-mapped according to EPA categories, and then GCAM's historical emissions were proportionally rescaled by gas, sector, and year, in order to account for remaining differences. The rescaling factors from GCAM's final calibration period (2015) were then carried forward to rescale emissions in future years by the same factor.

CO_2 emissions were harmonized for each of the following sectors: electricity, buildings, industry, transportation, and agriculture. Emissions from international transport and U.S. territories are handled separately. In addition to energy emissions, harmonization in the industry sector applies to CO_2 from oil and gas systems, cement, fertilizer production, and industrial feedstocks. Agriculture CO_2 includes liming and urea fertilization.

Non-CO_2 harmonization covers the following: CH_4 emissions from oil and gas systems, coal mining, landfills, and livestock; N_2O emissions from croplands, livestock, and nitric and adipic acid production; and emissions of HFC, PFC and SF6. Because GCAM 5.3 non-CO_2 emissions inventory is based on the Emissions Database for Global Atmospheric Research (EDGAR), it differs from the EPA inventories used for the purposes of calculating the emission reduction in the U.S. Biennial Report. Net CO_2 removal from natural and working lands in the U.S. was estimated separately, and added to the total GHG estimates.

Core Assumptions and Results

The results of this study depend on many assumptions about how the U.S. and the world might evolve in the future. This study uses a set of core assumptions for drivers including economic growth, population growth, fossil fuel prices, and energy demand (Supplementary Table 4). Economic impacts associated with COVID-19 in 2020 and subsequent recovery in the following years have also been incorporated into these assumptions. Our core assumptions draw from data sources such as EIA's *Annual Energy Outlook*,[65] the Federal Reserve System,[66] IMF's *World Economic Outlook*,[67] and Rhodium Group.[68,69] These assumptions lead to the results summarized in Figure 1 and Supplementary Table 5.

SUPPLEMENTARY TABLE 4. CORE ASSUMPTIONS FOR GCAM-USA-AP ANALYSIS

Drivers	Scenario Assumptions
Economic Growth	Overall GDP decreases by 3.5% year-on-year in 2020, then increases by 2.2% per year through 2030.
Population Growth	Population grows by 0.65% per year through 2030.
Fuel Prices	Gas price is assumed to drop by 19.5% year-on-year in 2020, then increase by 4.9% per year through 2030. Oil price is assumed to drop by 30.8% year-on-year in 2020, then increase by 6.2% per year through 2030.
Transportation Energy Demand	Transport sector energy demand is assumed to decrease by 7.3% from 2015 levels in 2020, with recovery through 2030.
Industry Energy Demand	Industry sector energy demand is assumed to decrease by 4.1% from 2015 levels in 2020, with recovery through 2030.
Buildings Energy Demand	Buildings sector energy demand is assumed to decrease by 2.3% from 2015 levels in 2020, with recovery through 2030.
Technology Costs	Technology costs are updated with NREL Annual Technology Baseline 2020 assumptions. Solar and wind base technology costs decrease by 49% and 42% from 2015 levels by 2030, respectively.

ANNEX 3: OVERVIEW OF FOOTPRINT METHODOLOGY

2021 Footprint Methodology

Proportion of U.S. Population, GDP, and Emissions

This portion of the analysis documents the aggregate size—expressed in percentage of total U.S. population, GDP, and emissions—of the coalitions formed explicitly to support the objectives of the Paris Agreement, focusing specifically on coalitions of states, counties, and cities. The three coalitions considered in this analysis are America Is All In (formerly We Are Still In), United States Climate Alliance, and Climate Mayors.[70,71,72,73]

For this analysis, city is defined as city proper based on geographic boundaries, not greater metropolitan areas that may include counties or towns outside of the city border. “City” may also refer to other subcounty entities, such as a town, village, or borough. Totals for population, GDP, and emissions are aggregations of the values for states, counties, and cities that are part of at least one coalition (for example, the total includes Columbus, OH, a city in America Is All In and Climate Mayors; Dallas County, TX, a county in America Is All In but not included in Climate Mayors; and Louisiana, a U.S. Climate Alliance state).

Adjustments for double counting:

Adjustments for double counting include:

- If a state, city, or county is in more than one coalition, they are only counted once.
- The analysis excludes cities and counties in states that are members of the U.S. Climate Alliance, and cities in counties already in America Is All In (or its predecessor, We Are Still In).

Population:

This study uses 2020 annual Census data estimates for population—including for states, the District of Columbia, Puerto Rico, counties, and cities.[74,75,76] Note that the team assessed potential impacts of the COVID-19 pandemic and found a <1% difference between 2019 and 2020 values. Total U.S. population is a sum of Census state, District of Columbia, and Puerto Rico totals.

GDP:

The study uses current-dollar GDP (in millions of dollars, seasonally adjusted at annual rates) from the BEA 2020 Q4 estimates for states (including the District of Columbia) and the World Bank GDP data for Puerto Rico.[77,78] County data is BEA 2019 real GDP (millions of chained 2012 dollars).[79] City GDP is calculated from county GDP based on the proportion of city population to total county population. Total U.S. GDP is a sum of BEA state, District of Columbia, and Puerto Rico totals.

Emissions:

All state, county, and city emissions are gross totals, including both CO_2 and non-CO_2 emissions. For state emissions, including the District of Columbia and Puerto Rico, the analysis uses Rhodium's ClimateDeck data based on 2019 EPA SIT gross total estimates.[80] County and city data are from NREL City and County Energy Profiles, hosted on OpenEI, which includes modeled estimates of electricity and natural gas consumption and expenditures, on-road vehicle fuel consumption, and vehicle miles traveled.[81] Total U.S. emissions are gross total emissions from the U.S. National Inventory.[82]

Map of Non-Federal Entities Committed to Climate Action

The research team also developed a map of non-federal entities committed to climate action (see Figure 1 in the main report, *Blueprint 2030: An All-In Climate Strategy for Faster, More Durable Emissions Reductions*). The map shows states, cities, tribal nations, businesses, universities, health care organizations, cultural institutions, and faith groups that have indicated their commitment to a net-zero future and the goals of the Paris Climate Agreement by joining America Is All In (formerly We Are Still In), the U.S. Climate Alliance, Climate Mayors, Race to Zero, or by setting a climate commitment via the Science Based Targets Initiative or Second Nature.[83,84,85] Map location is based on entity zip code, county code, or geographic coordinates derived from the 2019 America's Pledge Analysis.[86] For institutions with broadly dispersed geographic footprint (e.g., businesses), the location is based on headquarter address.

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