Biennial Report Appendix
"Additional Measures Consistent with the *Climate Action Plan*" Methodologies

This report assesses the potential range of greenhouse gas reductions that are achievable in 2020 based on estimates of the abatement potential from a range of possible additional measures.

The analysis conducted for this report sheds light on the potential scale of additional reductions through 2020 by assessing the broad categories of actions contained in the President's Climate Action Plan. Although many of the specific measures that scale up and expand existing efforts are already underway, several of the Plan's actions will require U.S. government agencies to develop recommendations, propose new rules, augment existing activities, and undertake processes that entail significant stakeholder outreach and public comment before final rules and programs are in place. Although the purpose of each action is clear, the exact shape and details of each will be developed over time. Until recommendations and rulemakings and other administrative activities for these specific actions are complete, it will not be possible to estimate the exact scale of emissions reductions that will be achieved by each specific action.

Starting with projections of U.S. emissions based on policies enacted before 2012 (Section 4 of the Biennial Report[1]), estimates of the additional reductions achievable by 2020 for three key categories of actions were assessed: Energy CO_2; HFCs; and Methane. Detailed methodologies for each are provided below.

Energy CO_2

Two scenarios, in addition to the reference scenario, were constructed using PI-NEMS[2], an integrated energy system model, to explore the potential impacts of extending and expanding existing policies and programs on energy CO_2 emissions. The model input assumptions for the reference case were based on the 2013 Annual Energy Outlook (AEO) Final Release. Projected CO_2 emissions were adjusted to match international inventory convention.[3]

The model input assumptions for Scenario 1 were based on the 2013 AEO Extended Policies side case with slight modifications for the transportation sector. It assumed that tax credits with sunset dates, such as the production and investment tax credits, are extended indefinitely, and that federal energy appliance and equipment energy efficiency standards and building codes are updated periodically. It also included power sector clean energy deployment that achieves 58% clean energy generation by 2020 – assuming clean energy generation includes electricity from renewables and other zero-carbon sources with half credit for electricity from efficient natural gas generation and partial credit for CCS based on the capture percentage. Under this definition, in 2012, clean

[1] These projections are identical to the projections used in Chapter 5 of the Climate Action Report.
[2] The version of NEMS utilized in this report has been run by OnLocation, Inc. with input assumptions determined by DOE's Office of Policy and International Affairs (PI). Since this analysis was commissioned by PI and uses a version of NEMS that differs from the one used by the U.S. Energy Information Administration (EIA), the model is referred throughout the document as PI-NEMS. The results described in this report do not necessarily represent the views of EIA.
[3] PI-NEMS estimates for CO_2 from fossil fuel combustion were adjusted for the purpose of these projections to remove emissions from bunker fuels and non-energy use of fossil fuels, and to add estimated CO_2 emissions in the U.S. territories consistent with international inventory convention. These changes, as well as the overall energy CO_2 forecast, are identical to projected emissions used in the U.S. Climate Action Report Chapter 5.

generation provided 47% of total generation. This scenario is broadly consistent with the President's goals of doubling electricity generation from wind, solar and geothermal by 2020 and generating 80% of all electricity from clean sources by 2035. The model input assumptions for end use sectors were developed externally and input into PI-NEMS to compute emission reductions from those outcomes in combination with the modeled response to the power sector clean energy targets.

The model input assumptions for Scenario 2 were the same as Scenario 1 except that it included greater clean energy deployment and existing federal programs are assumed to achieve additional energy savings primarily in areas not targeted by regulations and incentives in Scenario 1. These include reductions in vehicle miles travelled, improvements to existing residential and commercial building shells, accelerated deployment of new industrial CHP capacity, and reductions in industrial energy demand in several subsectors. The power sector clean energy deployment assumed in Scenario 2 achieves 62% clean generation by 2020. This scenario is also broadly consistent with the President's goals of doubling electricity generation from wind, solar and geothermal by 2020 and generating 80% of all electricity from clean sources by 2035. As in Scenario 1, the model input assumptions for end use sectors were developed externally and input into PI-NEMS to compute emission reductions from those outcomes in combination with the modeled response to the power sector clean energy targets.

The table below shows 2020 abatement by sector relative to the projection for BAU in 2020. Total abatement is 485 million metric tons under Scenario 1 and 800 million metric tons under Scenario 2. Direct emissions from the power sector are allocated across end use sectors.

	Direct + Indirect Abatement In million metric tons	
	Scenario 1	**Scenario 2**
Buildings	330	445
Transportation	15	45
Industry	140	310
Total	**485**	**800**

Methane

The abatement potential for CH_4 was estimated by applying the CH_4 marginal abatement cost (MAC) curve from the EPA report, *Global Mitigation of Non-CO_2 Greenhouse Gases*, to the baseline CH_4 emissions projections in Chapter 5 of the *Climate Action Report*. The *Global Mitigation of Non-CO_2 Greenhouse Gases* report provides country level marginal abatement cost (MAC) curves for all non-CO_2 greenhouse gases by sector. MAC curves are constructed for each region and sector from estimated abatement potential and bottom-up average breakeven price calculations for each mitigation option. The mitigation options are ordered producing a stepwise curve, where each point reflects the average cost and reduction potential if a mitigation technology were applied across the sector within a given region. In conjunction with appropriate baseline and projected emissions for a given sector the results are expressed in terms of absolute reductions of

carbon dioxide equivalents ($MtCO_2e$). This analysis makes no assumptions regarding specific policies that might encourage the implementation of mitigation options.

Based on the analysis running the MAC model against the Chapter 5 emissions baseline and projections, in 2020, the range of CH_4 abatement potential in 2020 relative to BAU for the purposes of this report is 25 to 90 $MtCO_2e$. This range reflects varying assumptions about the ability to achieve the full economic potential abatement represented in the MAC due to non-price barriers and the effectiveness of voluntary measures.

HFCs

The U.S. government has collaborated with the governments of Mexico and Canada to propose a Montreal Protocol amendment that would phase down production and consumption of, and control byproduct emissions of, hydrofluorocarbons (HFCs). The amendment calls for progressive global reductions in the consumption and production of HFCs through 2043. Additional emissions reductions are estimated assuming domestic implementation of actions to meet the requirements of the proposed amendment to the Montreal Protocol. National aggregate HFC production and consumption in CO_2eq terms must be reduced to 15% of a baseline by 2033 and 2043 for developed and developing countries, respectively, with milestones in intermediate years. Also, emissions of HFC-23 during the production of other fluorocarbons must be reduced significantly to remain below prescribed levels. The analysis of HFC emission reductions from these actions, summarized below, is given in EPA's *Benefits of Addressing HFCs under the Montreal Protocol*, June 2013.

The reductions from the HFC phase-down are analyzed assuming the United States meets the required reductions while complying with all other Montreal Protocol obligations, including completing the phase-out of remaining ozone-depleting substances. EPA's analysis assumes that several process and handling options and multiple alternative chemicals would be implemented to reduce or replace HFCs in the sectors where they are used today, reducing HFC consumption from the business-as-usual projection to levels necessary to meet the proposed amendment. Estimates of the emission patterns from various types of HFC applications, as set forth in the *Inventory of US GHG Emissions and Sinks: 1991-2011,* allows for the calculation of emission reductions.

The U.S. domestic estimate for HFC-23 emissions in 2020 is based in part on the *Inventory of US GHG Emissions and Sinks: 1991-2011* and the *Global Mitigation of Non-CO_2 GHGs* (2013) and *Climate Action Report* (2010). Reductions are then calculated, assuming these estimated emissions are reduced to comply with the 2013 proposal submitted by the United States, Canada and Mexico to address HFCs under the Montreal Protocol.

Depending on the specific actions taken to meet both the phase-down and byproduct emission obligations under the proposed amendment, HFC emission reductions in the year 2020 relative to BAU are estimated to be 100 to 135 $TgCO_2eq$. The estimate provided here was calculated using 100-year AR4 GWPs consistent with the proposed amendment.