On November 1, 2021, as the world commences the COP26 gathering in Glasgow, Scotland, for the next round of global climate negotiations, the White House, under the signatures of John Kerry, Special Presidential Envoy for Climate, and Gina McCarthy, National Climate Advisor, issued a strategy stating that achieving net-zero GHG emissions by 2050 is possible and outlining the broad steps for doing so. The Long-term Strategy of the United States: Pathways to Net-Zero Greenhouse Gas
Emissions by 2050 includes the following key elements:

1. **10-Year Action Timing:** The strategy focuses on actions to be taken “now and through this decade” as the critical timeframe for making the 2050 goal achievable.

2. **Expected Health Benefits:** The strategy states that reducing air pollution through clean energy will avoid 85,000 to 300,000 premature deaths – through 2050. The basis for this broad range is unclear in the report.

3. **Avoided Damages:** The strategy states that it will avoid $1-3 trillion in damages through 2050 in just the United States.

4. **Economic Growth Benefits:** The strategy states that investing in “nascent clean industries” will “propel sustained growth” with the U.S. potentially leading in battery, electric vehicle, and heat pump developing technologies “without sacrificing critical worker protections.”

5. **National Security Benefits:** In 2016, the White House issued a report on climate change’s role as a national security threat. The new strategy emphasizes that connection, stating that early action by the U.S. will “encourage faster climate action globally, including by driving down the costs of carbon-free technologies.” This aspect of the strategy may be read as being responsive to concerns that the developing world and even developed countries, like China, have been perceived as relying on the U.S. to make reductions without carrying their share of the burden.

6. **Focus on Five Key Transformations:** The strategy states that the following pathways, implemented simultaneously will be essential to achieving Net-Zero by 2050:
   
   1. Decarbonizing Electricity.
   2. Electrifying End Uses and Switching to Other Clean Fuels.
   3. Cutting Energy Waste (i.e., Efficiency Improvements).
   4. Focusing Beyond Carbon Dioxide (CO₂) – on Methane (CH₄), Hydrofluorocarbons (HFCs), and Nitrous Oxide (N₂O). The strategy emphasizes “comprehensive and immediate” actions for reducing non-CO₂ emissions in the U.S.
   5. Scaling Up CO₂ Removal from Sectors Like Agriculture. The strategy speaks to scaling up land carbon sinks and “engineered strategies.”

7. **Whole-of-Government Approach:** The strategy echoes President Biden’s Executive Order 14008 issued in January 2021, *Taking a Whole-of-Government Approach to the Climate Crisis*, which explained the Administration would implement a “[g]overnment wide approach that reduces climate pollution in every sector of the economy [that] … delivers environmental justice ….” The strategy calls for:
1. Federal Leadership

2. Innovation Driven through Federal Policies


4. All-of-Society Action - i.e., Non-Governmental Organizations, Universities, Cultural Institutions, Investors, Businesses.

**Approaches and Calculations Figures - How the Strategy Intends to Get to Net-Zero GHG in 2050**

The strategy’s overall approach is summarized by the following graphic:

As illustrated, the bulk of the planned reductions are from “Decarbonizing Electricity” and “Energy Transitions,” with the former being comprised of utilization of carbon capture technologies in combination with fossil fuels and zero carbon generation, and the latter including Hydrogen, Low Carbon Fuels, and Electrification. Though a high priority for the Administration, the contribution from methane reductions is not nearly as consequential as many of these other sources. The strategy states that methane is a significant priority because “globally, methane accounts for half of the net 1.0°C of warming already occurring” and that “rapidly reducing methane emissions is the single most effective strategy to reduce warming over the next 30 years and is crucial in keeping to the 1.5°C limit” because of methane’s relatively short lifetime in the atmosphere, compared to CO₂.
Regarding non-CO$_2$ emissions, the strategy states that it will target:

- **Methane from Energy Production**: The strategy indicates that “a large proportion of oil and gas methane emissions come from a small number of sources” and highlights expected mitigation requirements to include new equipment and modifications or upgrades, and changes in operational practices (inspection, repair, and maintenance). One issue that has been a high priority for the energy industry is utilizing remote technologies as much as possible to monitor methane leaks. It will be interesting to see how the Administration seeks to enable such remote activities, given the climate impacts of vehicle miles traveled to perform such activities.

- **Waste Methane from Landfills**: Landfills produce CH4 and other landfill gases through the natural process of bacterial decomposition of organic waste under anaerobic conditions. The strategy highlights this as a significant opportunity for reduction, stating that the methane mitigation potential from the waste sector non-CO$_2$ GHGs at $100/t$ is 8 MtCO$_2$e or 6% of total 2030 waste sector emissions.

- **Livestock Methane**: The strategy indicates that without altering underlying demand, the mitigation potential of livestock methane at $100/t$ is 70 MtCO$_2$e or 27% of 2030 livestock non-CO$_2$ GHG emissions and remains an important source of potential mitigation through 2050.

- **Cropland and Rice Production Methane**: The strategy states that methane produced by the anaerobic decomposition of organic matter in flooded rice fields has a mitigation potential at $100/t$ of 1.7 MtCO$_2$e or 1% of 2030 agricultural CH4 emissions.

Figure 5 of the strategy highlights the Administration’s vision for decarbonizing the electricity sector, showing large expansion of renewables, while continuing fossil fuel roles, largely paired with carbon capture utilization and sequestration (CCUS) technologies.
Figure 8 shows the vision for the transportation sector, with a dramatic and steep decline in fossil fuel powered vehicles and a correspondingly sharp increase in deployment of electric and alternative fuel vehicles:

Figure 5: U.S. Electricity Generation 2005-2050. Generation by source in trillion kilowatt-hours. Total generation expands to 2050 due to increased use of clean electricity in new applications in transportation, industry, and buildings. Renewable generation increases rapidly to keep pace with growing electricity demand and ensure that the share of renewables continues to expand to 2050. Note: Historical data are from EIA Monthly Energy Reviews, projections include data from all LTS scenarios using both GCAM and OP-NEMS, projections are shown in ten-year time steps.
The strategy provides similar estimates and approaches for reducing N\textsubscript{2}O, HFCs, and Black Carbon, though it contains much less detail.

Finally, an area that appears to be a relatively new emphasis is removing carbon directly from the atmosphere. While the strategy discusses land sinks, which have long been a focus, it also emphasizes the potential for new technologies:

1. **Biomass Carbon Removal and Storage.** This is a carbon dioxide removal approach where CO\textsubscript{2} is produced from the combustion, gasification, or other conversion of low- or zero-carbon biomass, for example to generate electricity or produce hydrogen, and the resulting CO\textsubscript{2} emissions are captured and then stored in a manner that prevents it from reentering the atmosphere.

2. **Direct Air Capture and Storage.** This is a technology that captures CO\textsubscript{2} emissions directly from ambient air (instead of from point sources, such as power plants or industrial facilities), via solvent, solid sorbent, or mineral processes. The captured CO\textsubscript{2} is then either compressed and sequestered permanently in a geological setting or converted into a usable material such as a synthetic aggregate in concrete production.

3. **Enhanced Mineralization.** This is a carbon dioxide removal (CDR) approach that accelerates natural geologic processes around mineral reactions with CO\textsubscript{2} from the ambient air, leading to permanent carbon storage through carbonate rock. Research and development for enhanced mineralization is still early, but the potential capacity of CO\textsubscript{2} mineralization could be quite high.
4. *Ocean-Based CDR.* This is a CDR approach that removes dissolved CO₂ from the ocean. Ocean-based approaches include nature-based approaches (e.g., kelp afforestation), engineered approaches (e.g., electrochemical CO₂ capture from seawater), or a combination of the two (e.g., growing macroalgae and sinking it to the sea floor). Ocean-based CDR is in early stages of research and development and merits closer study.

The components of the strategy are consistent in most respects with what stakeholders expected of the Administration’s positions, such as pushing for greater regulation of non-CO₂ GHGs. Because the Administration did not achieve its desired passage of federal climate-related legislation prior to the COP, which would have included a series of significant funding measures for climate mitigation, the strategy appears intended to serve as a signal to the parties at COP26 that the United States is moving forward seriously on a leadership role in the world on climate action and technology.

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