Non-CO₂ negative emission technologies (NETs) target greenhouse gases (GHGs) other than carbon dioxide. These include methane (CH₄), nitrous oxide (N₂O), and fluorinated gases (F-gases, such as hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride, and nitrogen trifluoride). These gases have higher global warming potentials (GWPs) compared to CO₂ and persist for varying durations in the atmosphere. Below is an overview of the primary GHGs amendable to NETs and the associated technologies:

**1. Methane (CH₄)**

**Primary Sources**: Agriculture (enteric fermentation, manure management), energy (natural gas leaks, coal mining), waste (landfills).

**NET Approaches**:

* **Methane oxidation**: Catalytic or photochemical oxidation converts CH₄ into CO₂ and water. While CO₂ is a GHG, its GWP is much lower than methane's.
* **Biochar amendments**: Applying biochar to soils or as a landfill cover can reduce methane emissions by enhancing microbial oxidation.
* **Methane-capture technologies**: Utilizing methane-oxidizing bacteria or engineered solutions to capture methane emissions at the source (e.g., from landfills or livestock).

**2. Nitrous Oxide (N₂O)**

**Primary Sources**: Agriculture (synthetic fertilizers, manure), industrial processes, combustion.

**NET Approaches**:

* **Nitrification inhibitors**: Chemicals that slow the conversion of ammonium to nitrate in soils, reducing N₂O emissions.
* **Biochar**: Enhancing soil properties to reduce N₂O emissions by improving nutrient use efficiency and denitrification processes.
* **Enzymatic decomposition**: Catalytic or bioengineered solutions to convert N₂O into nitrogen and oxygen.
* **Precision agriculture**: Leveraging technology to minimize fertilizer use while maintaining yields.

**3. Fluorinated Gases (F-Gases)**

**Primary Sources**: Industrial activities, refrigerants, air conditioning, semiconductor manufacturing.

**NET Approaches**:

* **Destruction technologies**:
  + **Plasma arc destruction**: Uses high-energy plasma to break down F-gases into less harmful compounds.
  + **Catalytic decomposition**: Employs specialized catalysts to break F-gases into inert or less harmful components.
* **Capture and reuse**: Recovery and recycling of refrigerants or industrial gases to prevent their release.
* **Natural alternatives**: Developing refrigerants and industrial chemicals with low GWPs as substitutes for F-gases.

**4. Hydrofluorocarbons (HFCs) and Similar Substances**

**Primary Sources**: Refrigeration, air conditioning, and aerosols.

**NET Approaches**:

* **Thermal destruction**: Controlled incineration in specialized facilities to destroy HFCs.
* **Cryogenic separation**: Freezing and separating HFCs for reuse or destruction.
* **Alternative technologies**: Transitioning to cooling systems with natural refrigerants (e.g., ammonia, CO₂).

**5. Black Carbon (BC)**

**Primary Sources**: Incomplete combustion of fossil fuels, biofuels, and biomass.

**NET Approaches**:

* **Improved combustion technologies**: Deploying stoves and engines that achieve near-complete combustion.
* **Filter technologies**: Retrofitting filters to capture particulate matter from emissions sources.
* **Soil incorporation**: Using captured BC as a soil amendment to sequester it long-term.

**Research Frontiers and Challenges**

* **Direct air capture** for non-CO₂ GHGs is less mature than for CO₂ and often focuses on capturing these gases at point sources.
* **Policy and incentives** are critical to scaling non-CO₂ NETs, particularly in sectors like agriculture where emissions are diffuse and challenging to manage.
* **Global standards** for monitoring, reporting, and verifying (MRV) non-CO₂ removals are less developed than for CO₂.

These NETs represent a growing frontier in climate mitigation, addressing high-GWP gases that significantly contribute to climate change despite their lower atmospheric concentrations relative to CO₂.

Set forth below is a chart highlighting a cross-section of efforts to develop and implement technologies aimed at reducing non-CO₂ greenhouse gases. But, there are many more—which is exactly what Net350 is exploring.

| **Greenhouse Gas** | **NET Approach** | **Key Organizations** | **Type** | **URL** |
| --- | --- | --- | --- | --- |
| **Methane (CH₄)** | Methane Oxidation | [Methane Action](https://www.methaneaction.org/) | NGO | [methaneaction.org](https://www.methaneaction.org/) |
|  |  | [University of California, Irvine](https://www.uci.edu/) | University | [uci.edu](https://www.uci.edu/) |
|  |  | [Environmental Defense Fund](https://www.edf.org/) | NGO | [edf.org](https://www.edf.org/) |
|  | Biochar Amendments | [International Biochar Initiative](https://biochar-international.org/) | NGO | [biochar-international.org](https://biochar-international.org/) |
|  |  | [Cornell University](https://www.cornell.edu/) | University | [cornell.edu](https://www.cornell.edu/) |
|  | Methane-Capture Technologies | [Carbon Mapper](https://carbonmapper.org/) | NGO | [carbonmapper.org](https://carbonmapper.org/) |
|  |  | [NASA Jet Propulsion Laboratory](https://www.jpl.nasa.gov/) | Governmental | [jpl.nasa.gov](https://www.jpl.nasa.gov/) |
|  |  | [Environmental Defense Fund](https://www.edf.org/) | NGO | [edf.org](https://www.edf.org/) |
| **Nitrous Oxide (N₂O)** | Nitrification Inhibitors | [Koch Agronomic Services](https://kochagronomicservices.com/) | Private Company | [kochagronomicservices.com](https://kochagronomicservices.com/) |
|  |  | [Yara International](https://www.yara.com/) | Private Company | [yara.com](https://www.yara.com/) |
|  | Biochar Application | [International Biochar Initiative](https://biochar-international.org/) | NGO | [biochar-international.org](https://biochar-international.org/) |
|  |  | [Cornell University](https://www.cornell.edu/) | University | [cornell.edu](https://www.cornell.edu/) |
|  | Precision Agriculture | [John Deere](https://www.deere.com/) | Private Company | [deere.com](https://www.deere.com/) |
|  |  | [Climate Corporation](https://climate.com/) | Private Company | [climate.com](https://climate.com/) |
| **Fluorinated Gases (F-Gases)** | Destruction Technologies | [Plasma Air](https://www.plasma-air.com/) | Private Company | [plasma-air.com](https://www.plasma-air.com/) |
|  |  | [Dürr Systems](https://www.durr.com/) | Private Company | [durr.com](https://www.durr.com/) |
|  | Capture and Reuse | [Hudson Technologies](https://www.hudsontech.com/) | Private Company | [hudsontech.com](https://www.hudsontech.com/) |
|  |  | [A-Gas](https://www.agas.com/) | Private Company | [agas.com](https://www.agas.com/) |
| **Black Carbon (BC)** | Improved Combustion Technologies | [Global Alliance for Clean Cookstoves](https://www.cleancookingalliance.org/) | NGO | [cleancookingalliance.org](https://www.cleancookingalliance.org/) |
|  |  | [Envirofit International](https://envirofit.org/) | Private Company | [envirofit.org](https://envirofit.org/) |
|  | Filter Technologies | [DieselNet](https://dieselnet.com/) | Private Company | [dieselnet.com](https://dieselnet.com/) |
|  |  | [Johnson Matthey](https://matthey.com/) | Private Company | [matthey.com](https://matthey.com/) |