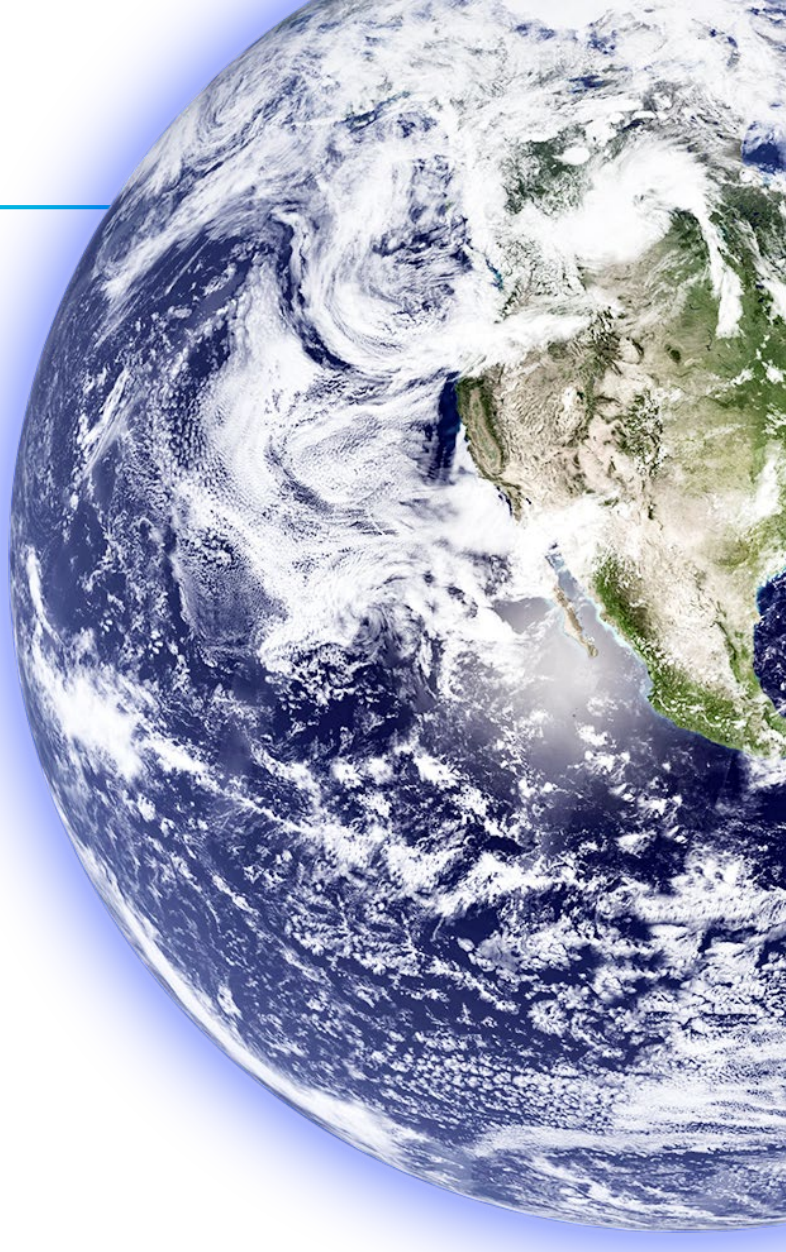
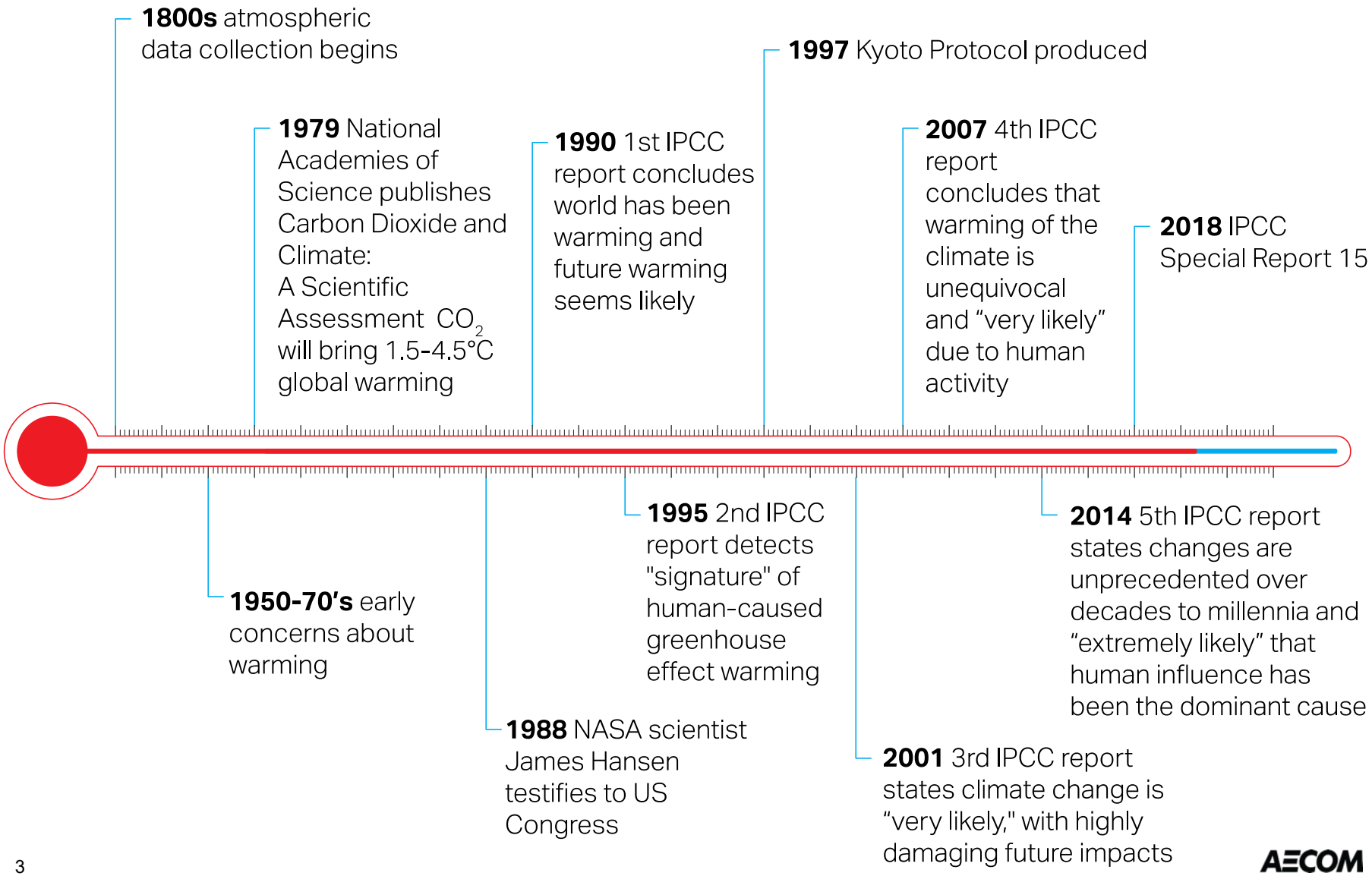
Greenhouse Gases 101

What is Climate Change?

Changes in global or regional climate patterns from a rise in average global temperatures **due to increase from human emissions** of greenhouse gases



Climate Change Science Timeline



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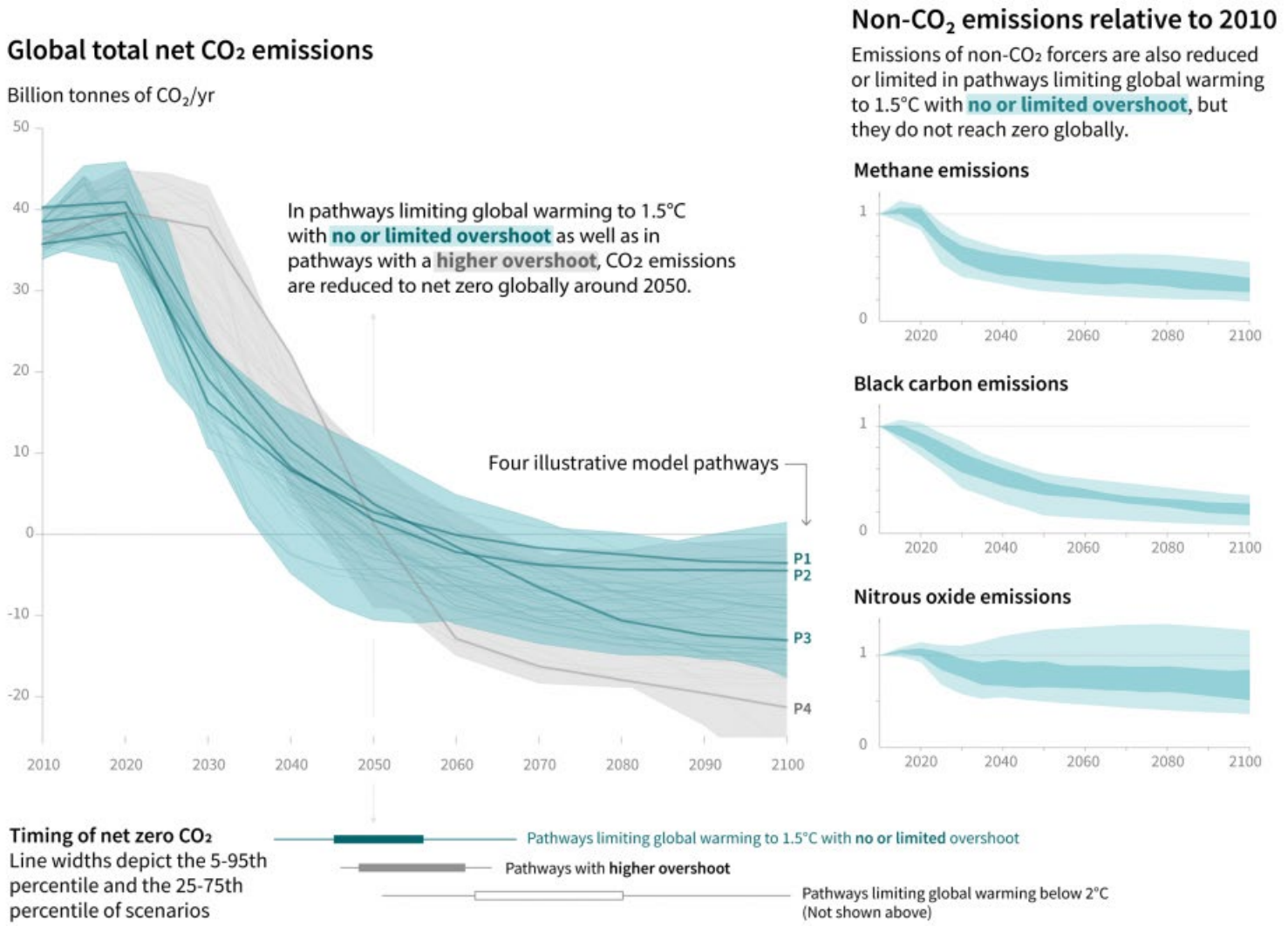
Intergovernmental Panel on Climate Change (IPCC)

Special Report - 15 Released October 2018
GHG Emissions Reduction Pathway



Source: IPCC Special Report on Global Warming of 1.5°C

Climate Change Impacts

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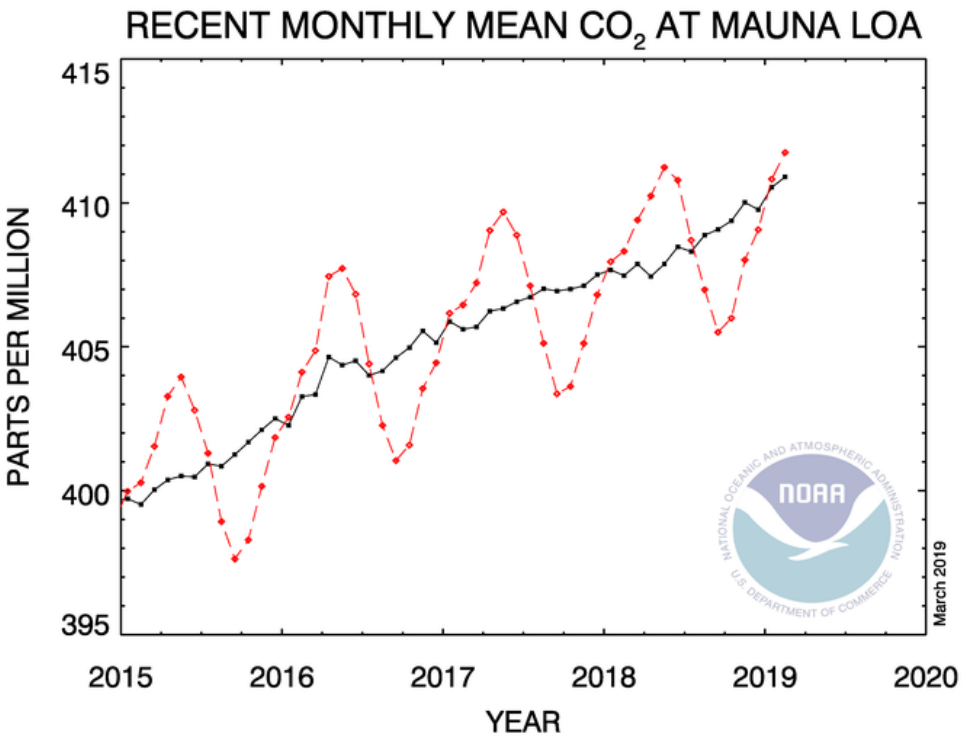
You Can’t Manage What You Can’t Measure

Measuring Parts Per Million (PPM)



- Safe levels of atmosphere concentrations of CO_2 is 350 ppm
- Current CO_2 records from Mauna Loa ~411 ppm
  - The last time CO_2 levels were this high, humans did not exist.
- PPM requirements can be converted to "carbon budgets"

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Carbon Budgets

- How much carbon can be emitted for a 66% chance of remaining below 1.5 °C of warming?
- Estimates range:
  - -192 to 779 gigatons CO_2

    Source: Carbon Brief Analysis: “How much ‘carbon budget’ is left to limit global warming to 1.5C?”
- Per person is maximum (assuming equal distribution):
  - 101 metric tons CO_2 total
- Hawaii per capita emissions currently:
  - ~15 metric tons CO_2 annually

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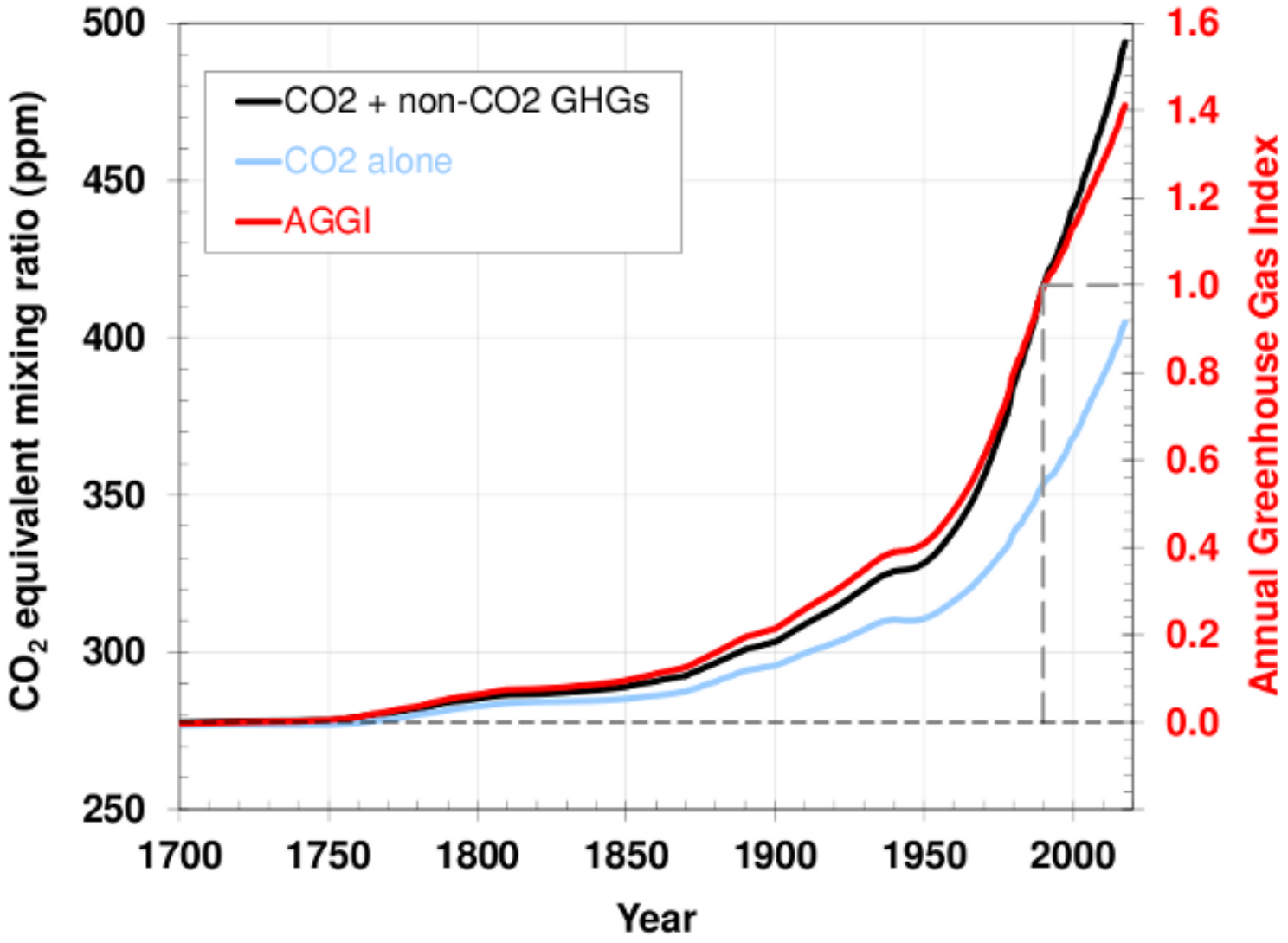
Other Greenhouse Gases



Source: NOAA Earth System Research Laboratory, ANNUAL GREENHOUSE GAS INDEX, Keeling et al., 1958, Machida et al., 1995, Battle et al., 1996, Etheridge, et al., 1996; Butler, et al., 1999

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Regularly Regulated/Inventoried Greenhouse Gases

- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous oxide (N_2O)
- hydrofluorocarbons (HFCs)
- perfluorocarbons (PFCs)
- sulfur hexafluoride (SF_6)

Global Warming Potential (GWP) and CO_2 equivalent

Greenhouse Gas	20-yr GWP	100-yr GWP	500-yr GWP
carbon dioxide (CO_2)	1	1	1
methane (CH_4)	56	21	6.5
nitrous oxide (N_2O)	280	310	170
hydrofluorocarbons (HFCs)	460-9,000	140-11,700	42-9,800
perfluorocarbons (PFCs)	4,400-6,200	6,500-9,200	10,000-10,100
sulfur hexafluoride (SF_6)	16,300	23,900	34,900

Source: UNFCCC *Climate Change 1995, The Science of Climate Change: Summary for Policymakers and Technical Summary of the Working Group I Report*

Greenhouse Gas Sources

Energy

- Stationary Combustion
- Transportation
- Incineration of Waste
- Oil and Natural Gas Systems
- International Bunker Fuels
- CO_2 from Wood Biomass and Biofuel Consumption

Greenhouse Gas Sources

Industrial Processes and Product Use

- Cement Production
- Electrical Transmission and Distribution
- Substitution of Ozone Depleting Substances

Greenhouse Gas Sources

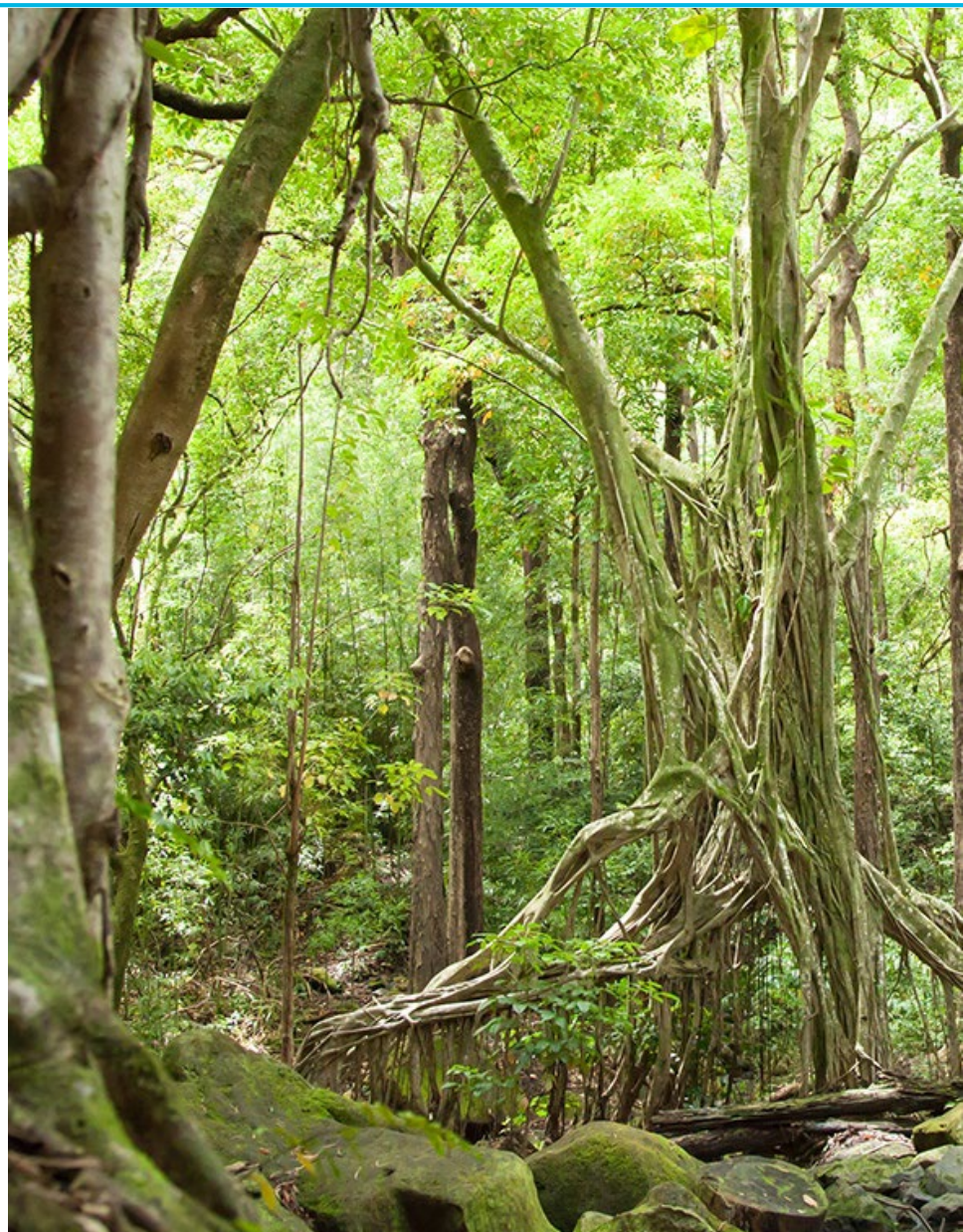
Agriculture, Forestry, and Other Land Use (Sources)

- Enteric Fermentation
- Manure Management
- Agricultural Soil Management
- Field Burning of Agricultural Residues
- Agricultural Soil Carbon
- Forest Fires

Greenhouse Gas Sources

Agriculture, Forestry, and Other Land Use (Sinks)

- Landfilled Yard Trimmings and Food Scraps
- Urban Trees and Forest Carbon



Greenhouse Gas Sources

Waste

- Landfills
- Composting
- Wastewater Treatment

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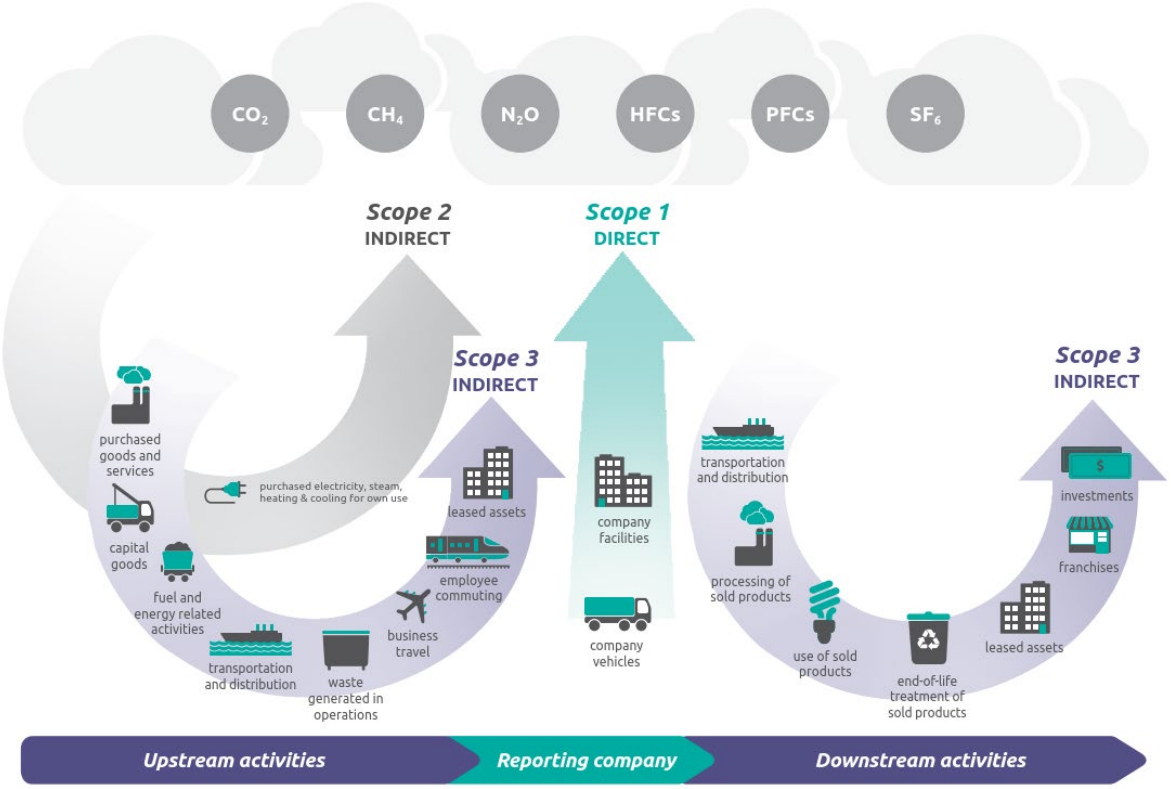
GHG Inventory Methods and Protocols

- 2006 IPCC Guidelines for National Greenhouse Gas Inventories,
- U.S. Environmental Protection Agency's (EPA) Greenhouse Gas Reporting Program (GHGRP),
- U.S. EPA's Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015, and EPA's State Inventory Tool (SIT), and
- World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), GHG Protocol

Inventory Scopes



- Division by Scopes is typically not used for state or national level GHG inventories
- Scopes are generally used by cities, corporations, or smaller agencies for GHG accounting.

Source: World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), GHG Protocol

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How does State of Hawaii Inventory GHG Emissions?