

CARBON DIOXIDE TRANSPORT, INJECTION, AND GEOLOGIC STORAGE IN THE INVENTORY OF U.S. GREENHOUSE GAS EMISSIONS AND SINKS

WGIA20 - June 2023

Vincent Camobreco

Climate Change Division

Office of Atmospheric Protection

US Environmental Protection Agency



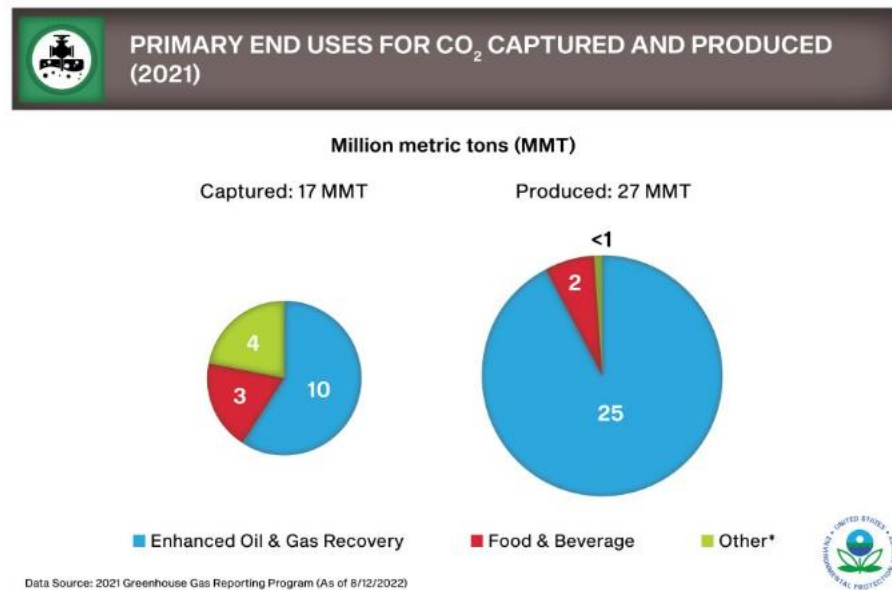
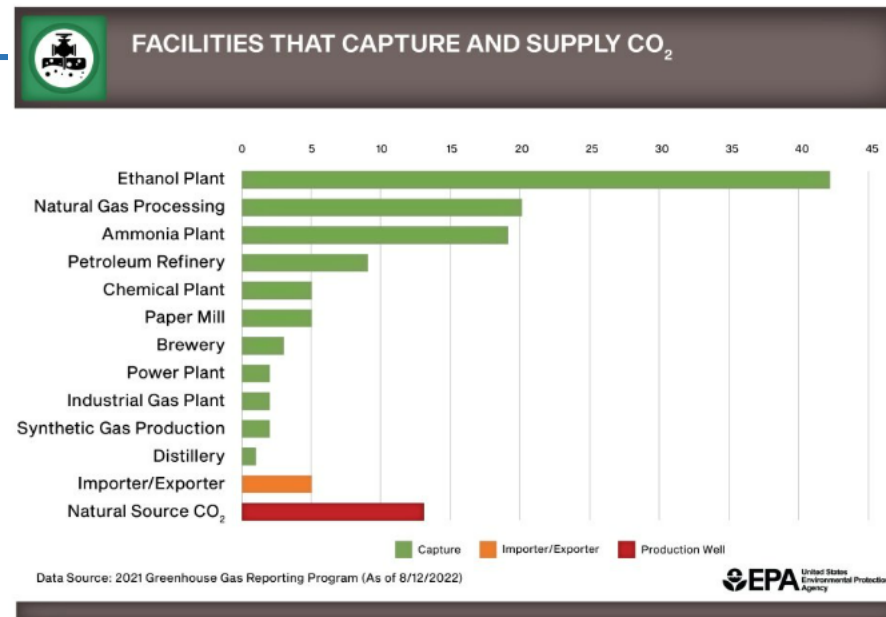
Presentation Outline

- US Situation
- US Greenhouse Gas Reporting Program and Data Collected
- IPCC Guidance on Inventory Reporting
- US Current Inventory Reporting
- Challenges
- Other Considerations
- Addressing Challenges / Future Data Availability
- Next Steps / Lessons Learned

US Situation

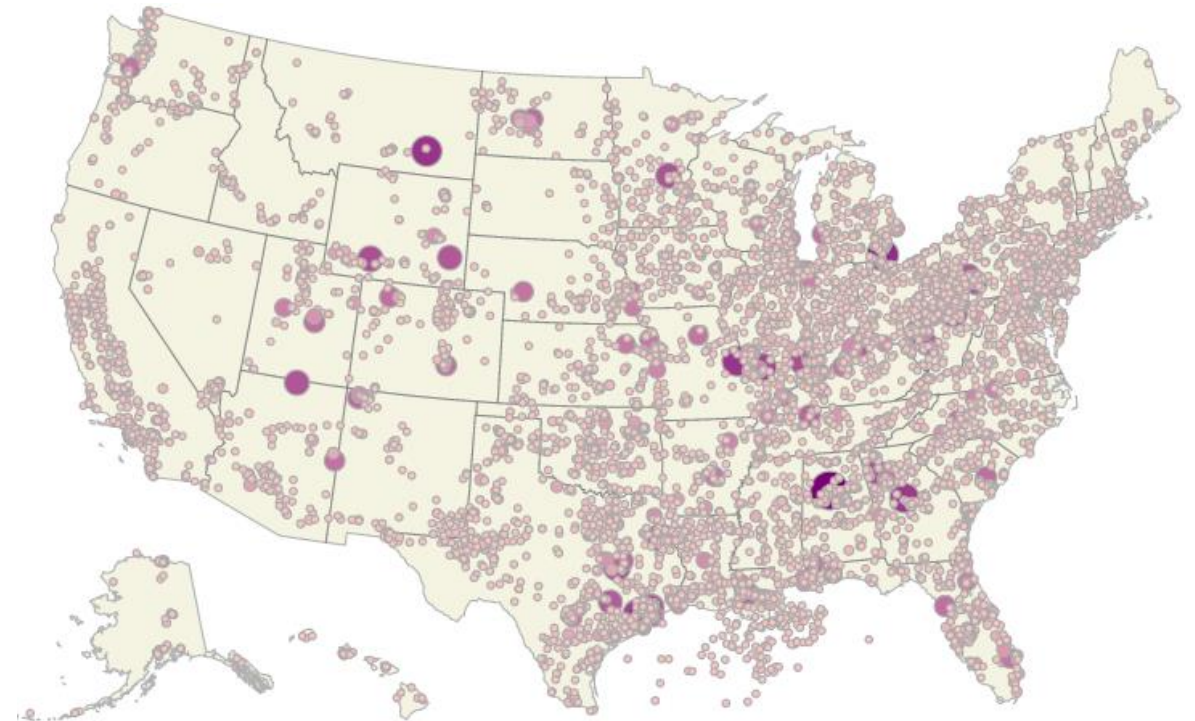
- CO₂ is captured / supplied from a number of different sources
 - Industrial sources
 - Fossil sources such as natural gas processing and chemical plants
 - Biogenic sources such as ethanol production
 - Natural sources (CO₂ produced / mined from natural domes)
- CO₂ is used in a number of applications
 - Enhanced oil and gas recovery (EOR)
 - Food and Beverage
 - Other*
 - Geologic Sequestration

* Includes cleaning and solvent use, fumigants and herbicides, transportation and storage of explosives, fire-fighting equipment, industrial and municipal water/wastewater treatment, pulp and paper, metal fabrication and greenhouse plant growth



Facility-Level National Greenhouse Gas Data

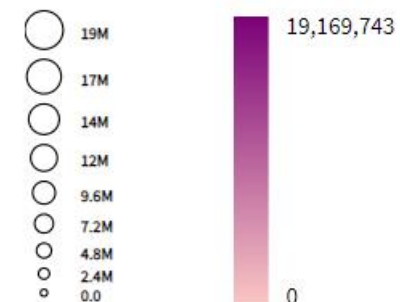
- The **Greenhouse Gas Reporting Program (GHGRP)** collects GHG data across all sectors of the U.S. economy under Clean Air Act authorities.
- Since 2010, GHGRP has **collected, verified and published** detailed annual data on emissions from over 8,000 facilities across 41 industrial source categories in the U.S., covering **85-90%** of total U.S. emissions.
- This data **supports and improves** the Inventory of U.S. Greenhouse Gas Emissions and Sinks, supports policy development, and informs industry, state and local governments, the research community, and the public.
- The program includes coverage of unique sources, including:
 - Specialized expertise in oil and gas data
 - Specialized expertise in fluorinated gas emissions
 - **Specialized expertise in carbon capture and sequestration**



GHGRP 2019 GHG
Emissions by Location

Metric tons CO₂e

Legend



Data Collected Through the GHGRP

- Our Greenhouse Gas Reporting Program (GHGRP) collects data on CO₂ capture as well as the main areas it is transfer to

Data from GHGRP on Capture for 2010-2021 (million metric tons CO₂)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
CO₂ Produced (Natural Domes) transferred to:												
Food and Beverage	1.9	1.5	1.4	1.5	1.6	1.6	1.5	1.2	1.2	1.4	1.7	1.8
EOR	44.8	48.4	48.9	47.0	46.2	41.8	36.5	38.1	36.4	37.4	25.3	25.0
Other	2.0	0.1	0.0	1.4	3.1	2.3	0.8	1.4	1.2	0.1	0.2	0.3
CO₂ Captured (Industrial Sources) transferred to:												
Food and Beverage	2.5	2.6	2.6	2.7	2.9	3.4	3.2	3.4	3.0	3.4	3.3	3.2
EOR	9.9	9.9	9.3	12.2	13.1	12.2	10.2	11.5	12.0	14.7	9.9	10.1
Other	3.6	3.9	4.1	3.7	4.5	3.6	3.9	4.3	4.7	4.1	4.3	5

- The GHGRP also has data on how much CO₂ is geologically sequestered

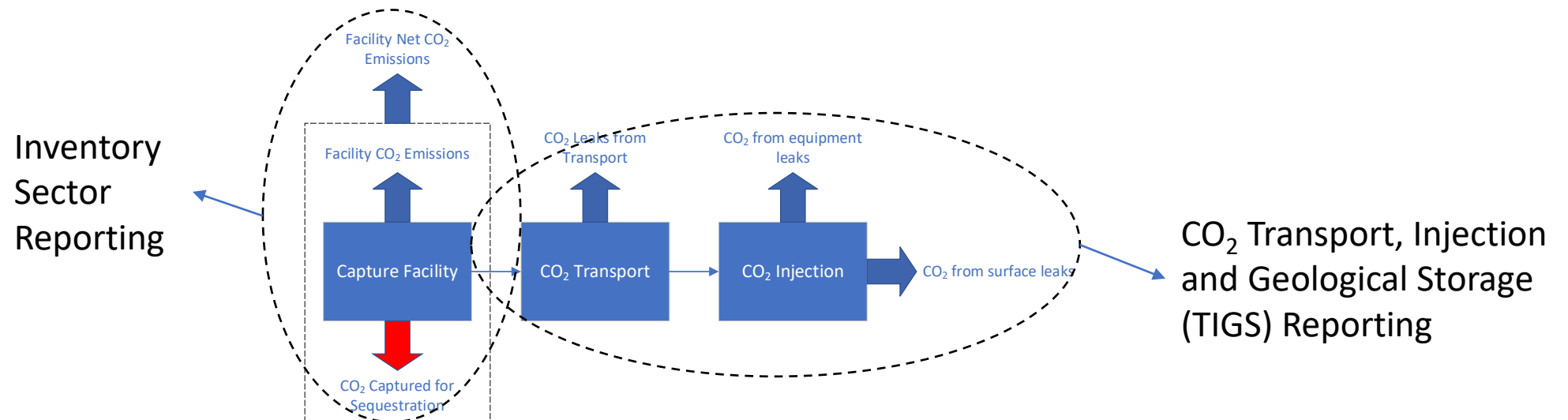
Data from GHGRP on Sequestration for 2016-2021 (metric tons CO₂)

Total:						
	2016	2017	2018	2019	2020	2021
CO ₂ sequestered	3,090,608	5,958,385	7,661,556	8,332,420	6,802,416	6,947,126
CO ₂ equipment leaks	9,818	9,577	11,023	15,621	13,493	37,145
CO ₂ surface leaks	0	0	0	0	22,975	25,544

IPCC Guidance on CCS Reporting

Carbon Capture and Geologic Sequestration (CCS) is accounted at the source of capture and by considering emissions associated with CO₂ Transport, Injection and Geological Storage (TIGS)

- **Source of Capture:** CO₂ captured for long term storage should be netted out under the IPCC sector in which capture takes place (e.g., Stationary Combustion or Industrial Activities)
 - See for example the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2, Chapter 2, Section 2.3.4
 - Note: quantities of CO₂ captured for later use and short-term storage should not be deducted from CO₂ emissions at the source of capture except when the CO₂ emissions are accounted for elsewhere in the inventory
- **CO₂ TIGS:** Fugitive emissions from the systems used to transport captured CO₂ from the source to the injection site and fugitive emissions from activities and equipment at the injection site and those from the end containment once the CO₂ is placed in storage are counted as part of CO₂ TIGS reporting
 - See the 2006 IPCC Guidelines for National Greenhouse Gas Inventories Volume 2, Chapter 5
 - Note: the IPCC does not provide a default method or emission factors for geological storage of CO₂, and instead recommends that countries develop Tier 3 country specific monitoring approaches to track any potential post-injection release of CO₂ to the atmosphere



US Inventory Accounting at Source of CO₂ Capture

- CO₂ capture is treated somewhat differently for the different capture sources in the Inventory
- Generally, CO₂ captured for sequestration is not currently deducted at the source category
- The exception is for categories where net emissions are captured as part of the calculation methodology
 - The GHGRP defines methods to calculate net emissions from petroleum refining
 - The GHGRP defines methods to calculate net emissions from natural gas processing
- Some other sources also account for CO₂ capture as part of the calculation methodology
 - CO₂ captured during lime production and reused in the process is netted
 - Some CO₂ produced by the Dakota Gasification Plant is exported to Canada, it is accounted for by reducing coal energy use associated with the amount of CO₂ exported
 - Process CO₂ from ammonia production used for urea production is subtracted but then accounted for under urea use (e.g., emitted from urea use in industrial or agricultural applications)

US Inventory CO₂ TIGS Accounting

- Not currently reporting any values as part of CO₂ TIGS (CRF Table 1.C), emissions reported as IE in current common reporting format (CRF) tables

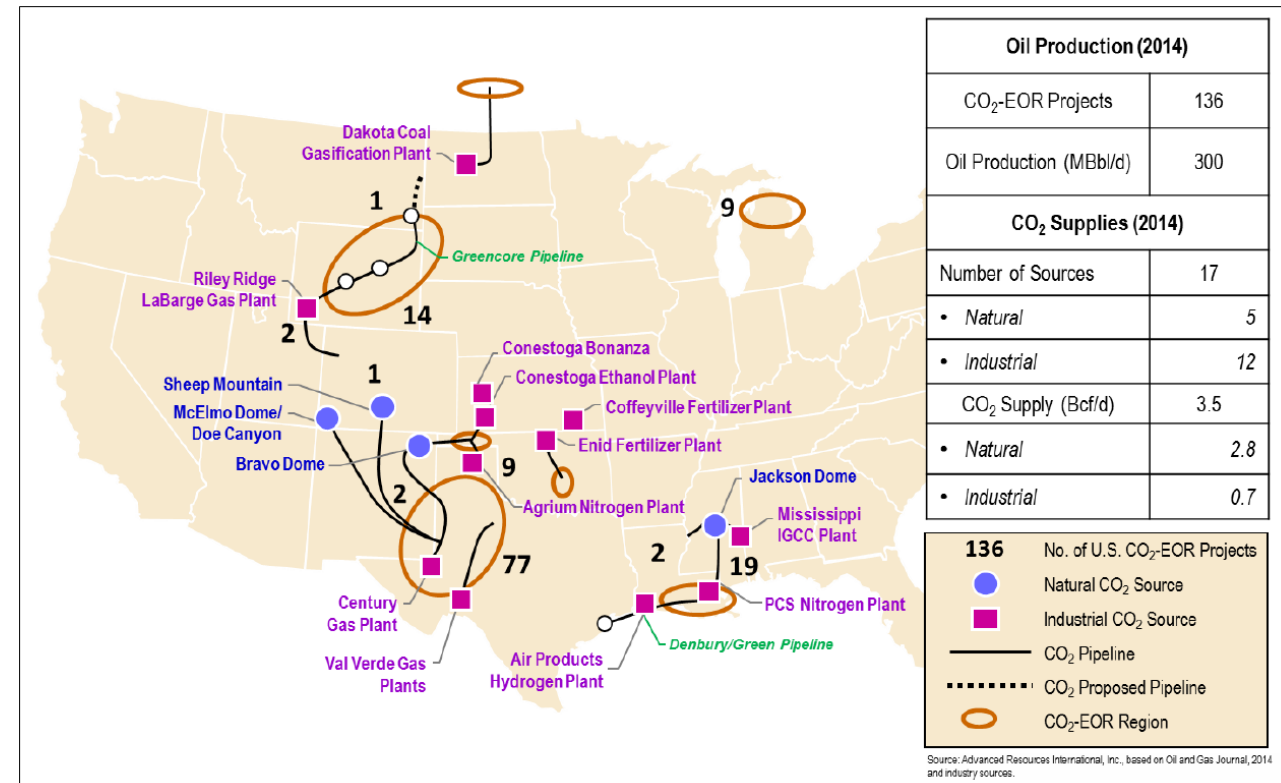
TABLE 1.C SECTORAL BACKGROUND DATA FOR ENERGY Inventory 2021
CO₂ Transport and storage Submission 2023 v1
(Sheet 1 of 1) UNITED STATES OF AMERICA

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	ACTIVITY DATA		IMPLIED EMISSION FACTORS		EMISSIONS	
	CO ₂ transported or injected ⁽¹⁾ (kt)		CO ₂ (kg/kt)		CO ₂ ⁽²⁾ (kt)	
1. Transport of CO ₂		IE		IE		IE
a. Pipelines		IE		IE		IE
b. Ships		IE		IE		IE
c. Other		IE		IE		IE
2. Injection and storage ⁽³⁾		IE		IE		IE
a. Injection		IE		IE		IE
b. Storage		IE		IE		IE
3. Other		IE		IE,NA		IE,NA
Information item ^(4,5)						
Total amount captured for storage						IE
Total amount of imports for storage						NO
<i>Total A</i>						NO,IE
Total amount of exports for storage						IE
Total amount of CO ₂ injected at storage sites						IE
Total leakage from transport, injection and storage						IE
<i>Total B</i>						IE
<i>Difference (A-B)⁽⁶⁾</i>						NO,IE

- In the Inventory estimates for oil and gas fugitive emissions, the Tier 2 emission factors for CO₂ include any CO₂ that was originally injected and is emitted along with other gas from leak, venting, and flaring pathways (i.e., emissions are included in data reported in CRF table 1.B.2)

Challenges

- The GHGRP has data on the amount of CO₂ captured as well as end uses for the captured CO₂, however, the amount of CO₂ captured by facility is generally considered Confidential Business Information (CBI) under the GHGRP and is not available by facility
- Furthermore, it is difficult to trace the CO₂ sequestered to the source of CO₂ capture
 - Because CO₂ pipelines often transport CO₂ from a mix of sources, it can be difficult to determine the source category of captured and sequestered CO₂ (e.g., the Permian Basin which has several sequestration sites has multiple CO₂ sources connected to the system including natural CO₂ and industrial CO₂ sources)
 - Once the source of the captured carbon and the end use are identified, the use of the CO₂ must be categorized and aligned with IPCC source categories as best as possible, the EPA must determine if the captured carbon should be removed (or it is already removed) and if so, from which source category



Other Considerations

- The Inventory includes a country specific category of emissions from carbon dioxide consumption
 - This includes emissions from CO₂ use other than EOR
 - For the years 1990-2009 the emissions are based on CO₂ extracted from natural sources and the assumed percent that does not go to EOR
 - For 2010 on the emissions are based on GHGRP data for CO₂ used in food and beverage applications from both natural and industrial sources
 - With future improvements this category may be included in other reporting so may no longer be needed
- Currently in the Inventory, CO₂ used in EOR operations is implicitly accounted for in a couple of different ways
 - For EOR CO₂ received from natural sources it is considered long term storage in that the CO₂ is not treated as an emissive source
 - For CO₂ received from industrial sources it does not necessarily count as long term storage since emissions are not being subtracted at the source of capture (with the exception of NG processing and petroleum refining)

Addressing Challenges / Future Data Availability

- EPA has proposed several updates to the GHGRP rules including considering EOR for sequestration
 - The proposal would create a reporting pathway for EOR operators who use the ISO 27916:2019 standard (ISO standard) to quantify the CO₂ sequestered as a result of their operations
 - The ISO standard has requirements for a site-specific monitoring, reporting and verification (MRV) plan in order to report geologic sequestration, similar to what is reported under the GHGRP for sequestration facilities
 - Should EOR facilities start to report using the updated GHGRP requirements it would help to update treatment of CO₂ captured for EOR in the Inventory
- Currently GHGRP reporting requirements for CO₂ captured from an electricity generating unit and transferred to a sequestration facility requires tracking details
 - This provides a more direct link between carbon capture and sequestration in terms of Inventory adjustments
 - The same type of information could potentially be requested of other capture facilities through a GHGRP rulemaking change

Next Steps / Lessons Learned

- This is an important category to ensure our Inventory reflects mitigation efforts to support our Nationally Determined Contribution (NDC)
- EPA shared as part of our Inventory expert review process a memo on possible options for accounting for carbon capture and CO₂ TIGS in the Inventory as part of the 2022 and 2023 submissions
- We received some initial comments on possible methods for accounting for carbon capture and CO₂ TIGS based on the GHGRP data
- There are ongoing rulemakings that will impact carbon capture (e.g., limits on power plant emissions and incentives for H production w/ CCS)
- Given the regulatory context and evolving data availability, waiting to have several years of data provides a better understanding of activity and trends
- Reporting in UN submission also requires other work (e.g., uncertainty estimation)

CONTACT Us:



EMAIL:

GHGI.TRANSPARENCY@EPA.GOV



WEBSITE:

**[HTTPS://WWW.EPA.GOV/GHGEMISSIONS/CAPACITY-
BUILDING-NATIONAL-GREENHOUSE-GAS-INVENTORIES](https://www.epa.gov/ghgemissions/capacity-building-national-greenhouse-gas-inventories)**



Transparency Accelerator for Greenhouse Gas Inventories



Transparency Accelerator for Greenhouse Gas (GHG) Inventories

EPA capacity building initiative to help developing countries establish, maintain, and improve sustainable greenhouse gas (GHG) inventory management systems that enable high-quality inventory reports, consistent with the *2006 IPCC Guidelines for National Greenhouse Gas Inventories*.

Motivation

- **A GHG inventory is an essential tool** for understanding current emissions and trends, projecting future scenarios, and identifying cost-effective mitigation opportunities.
- Many **developing countries have identified challenges** in implementing aspects of the *2006 IPCC Guidelines*, which are required under the Enhanced Transparency Framework (ETF) under the Paris Agreement starting in 2024.

EPA's Approach

- To **develop tools** and **work directly with national inventory teams** to help build institutional and technical capacity for sustainable GHG inventory management systems.

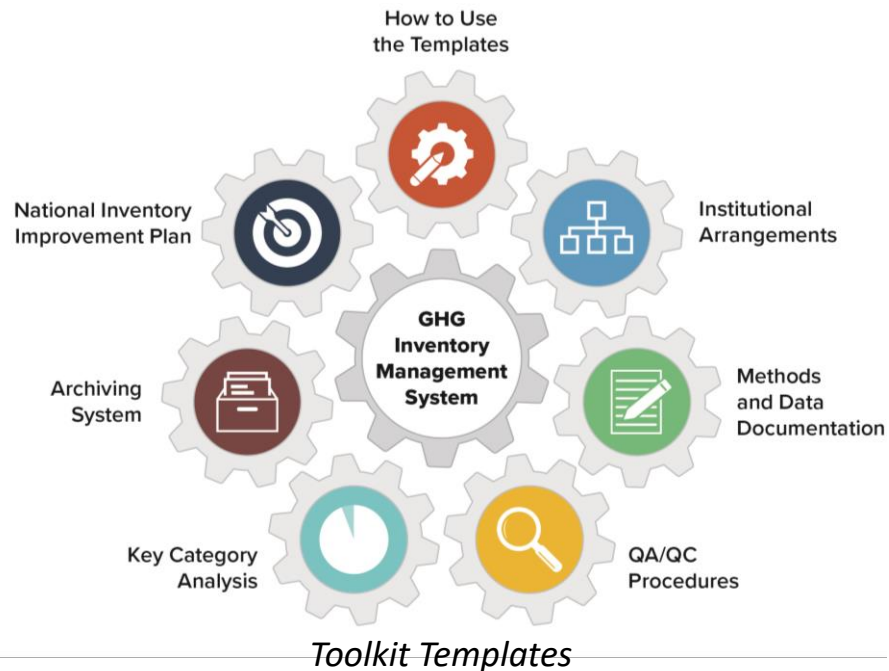


Contact us: ghgi.transparency@epa.gov

Available Tools & Resources

EPA Toolkit for Building National Greenhouse Gas Inventory Systems

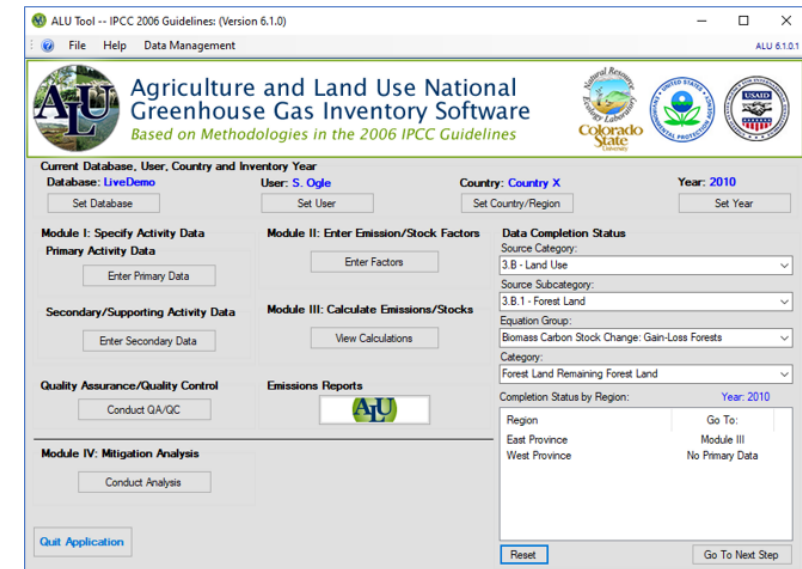
Customizable Templates to help inventory compilers build and advance GHG inventory management systems that suit their national circumstances.



Available at: <https://www.epa.gov/ghgemissions/toolkit-building-national-ghg-inventory-systems>

Agriculture and Land Use (ALU) Greenhouse Gas Inventory Software

Software tool to help inventory compilers estimate emissions and removals from agricultural and forestry activities.



ALU Tool Interface

Available at: <https://www.nrel.colostate.edu/projects/alusoftware/home>