

Status Report: Estimating greenhouse gas emissions from fossil fuels produced from Federal lands

Federal Lands Greenhouse Gas Emissions
and Sequestration Project (FLGGES)

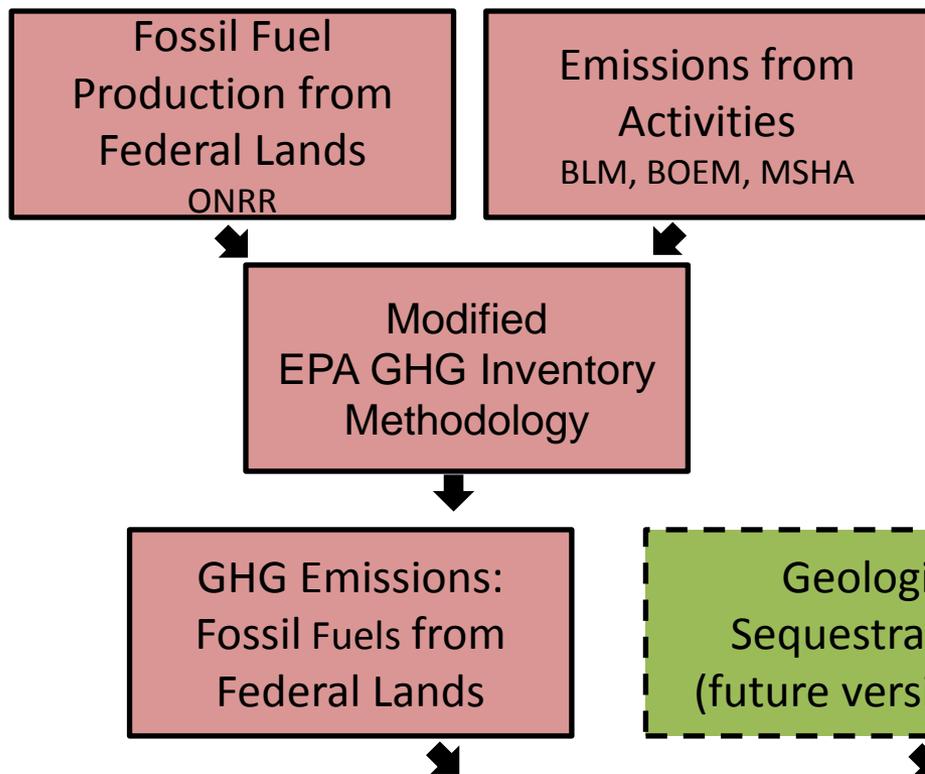
December 2, 2016

Outline

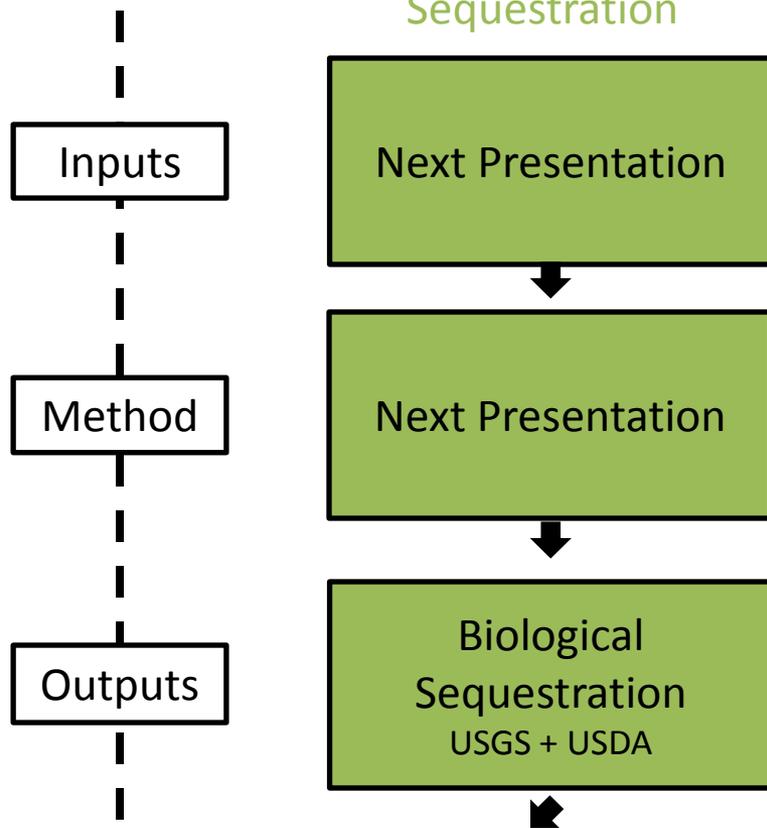
- Project summary and goals
- Comparison to EPA work
- Federal lands fossil fuel production
- National emissions
- USGS methodology
- Challenges
- Moving forward

Basic FLGGES Method

Emissions



Sequestration



NET EMISSIONS

Department of Interior

- Office of Natural Resources Revenue (ONRR)
- Bureau of Land Management (BLM)
- Bureau of Ocean Energy Management (BOEM)

Additional Agencies

- Environmental Protection Agency (EPA)
- U.S. Department of Agriculture (USDA)
- Mine Safety and Health Administration (MSHA)

How is this Different from EPA Greenhouse Gas (GHG) Inventory?

- EPA GHG Inventory produces a national-level calculation of all anthropogenic GHG emissions and sinks.
- USGS approach is based on the EPA GHG Inventory, but reports results for...
 - Only emissions related to fossil fuel extraction from Federal lands
 - Federal lands by State
 - Emissions for exported Federal fossil-fuel combustion

In Summary...

	EPA GHG Inventory	USGS FLGGES Inventory
All GHG emissions	😊	CO ₂ , CH ₄ , N ₂ O
National estimates	😊	
State level Federal lands emissions estimates		😊
Exported fuels	Upstream only	😊

The USGS FLGGES Method...

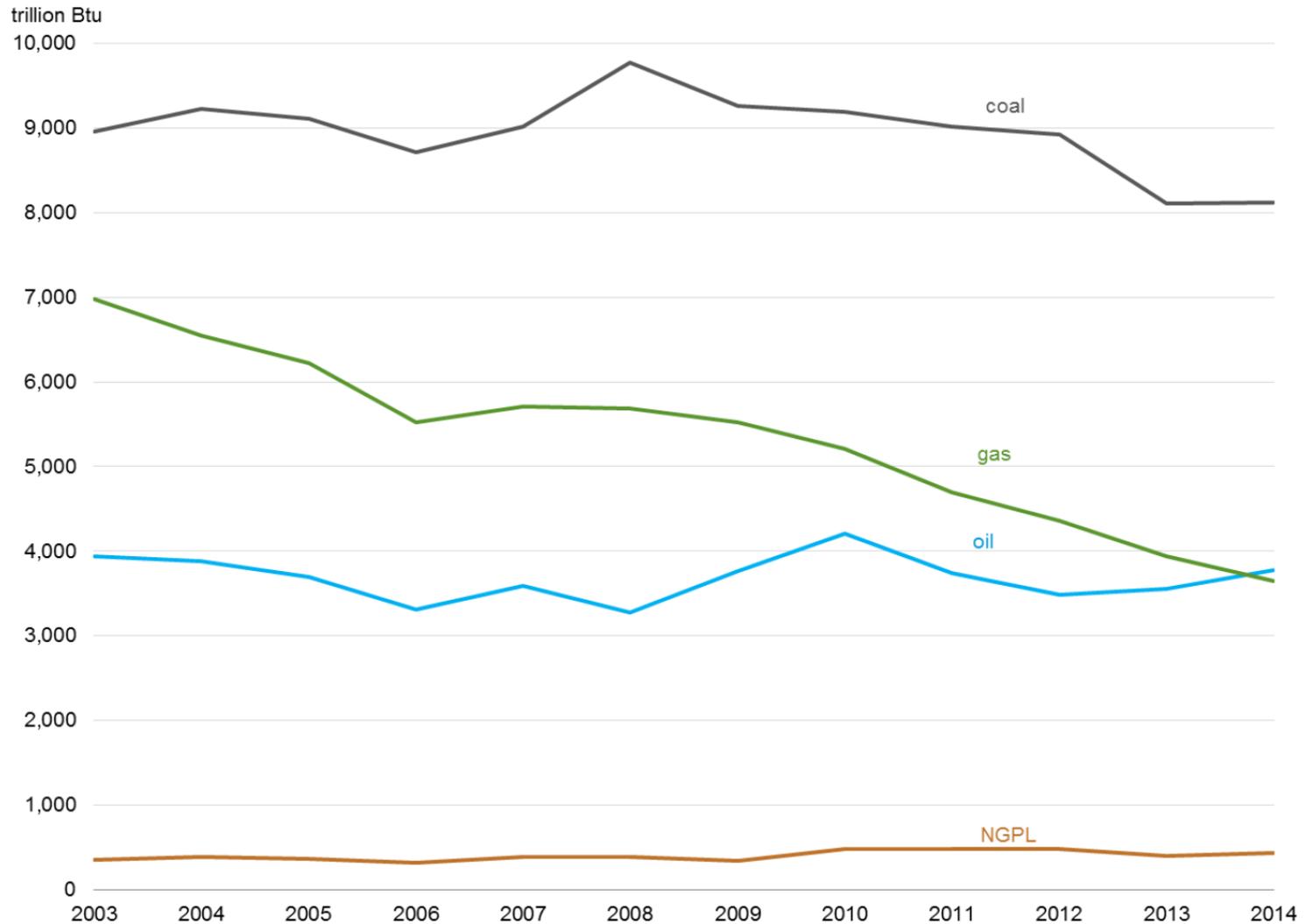
- Provides a calculation method to estimate the emissions generated by fossil fuels produced on Federal lands at the State level.
- Based on EPA and United Nations' IPCC methods for GHG emissions, though modified where needed.
- A mathematical calculation, not a subjective assessment procedure.

EPA (2016, Inventory); IPCC (2006)

The USGS FLGGES Method Does NOT...

- Track fuels. Products are NOT tracked from cradle to grave.
 - Emissions are estimated based on the amount of fossil fuels produced.
- Break down Federal lands emissions at the agency level (BLM, USFS, DoD etc.)
- Include American Indian lands at this time. Only Federal lands were evaluated.

Federal Lands Fossil Fuel Production

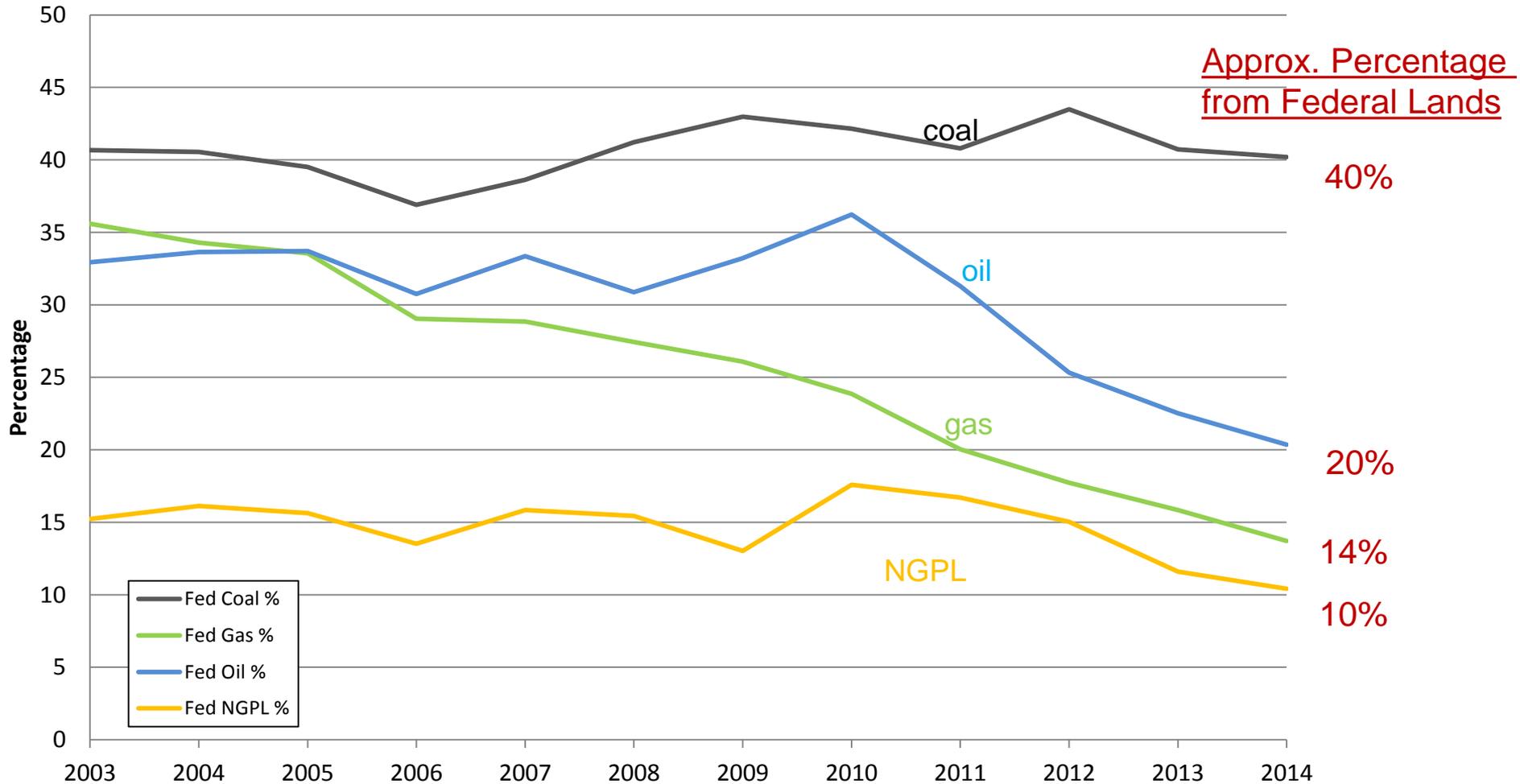


EIA (2015, fig. 1)



Abbreviations: U.S. Energy Information Administration (EIA); natural gas petroleum liquids (NGPL); British thermal unit (Btu)

Federal Lands Production as Percentage of National Production



Data source: EIA (2015; 2016, table 1.1)

Fossil Fuel Carbon Flow Chart (MMT CO₂ Eq.)

Approx. Percentage from Federal Lands

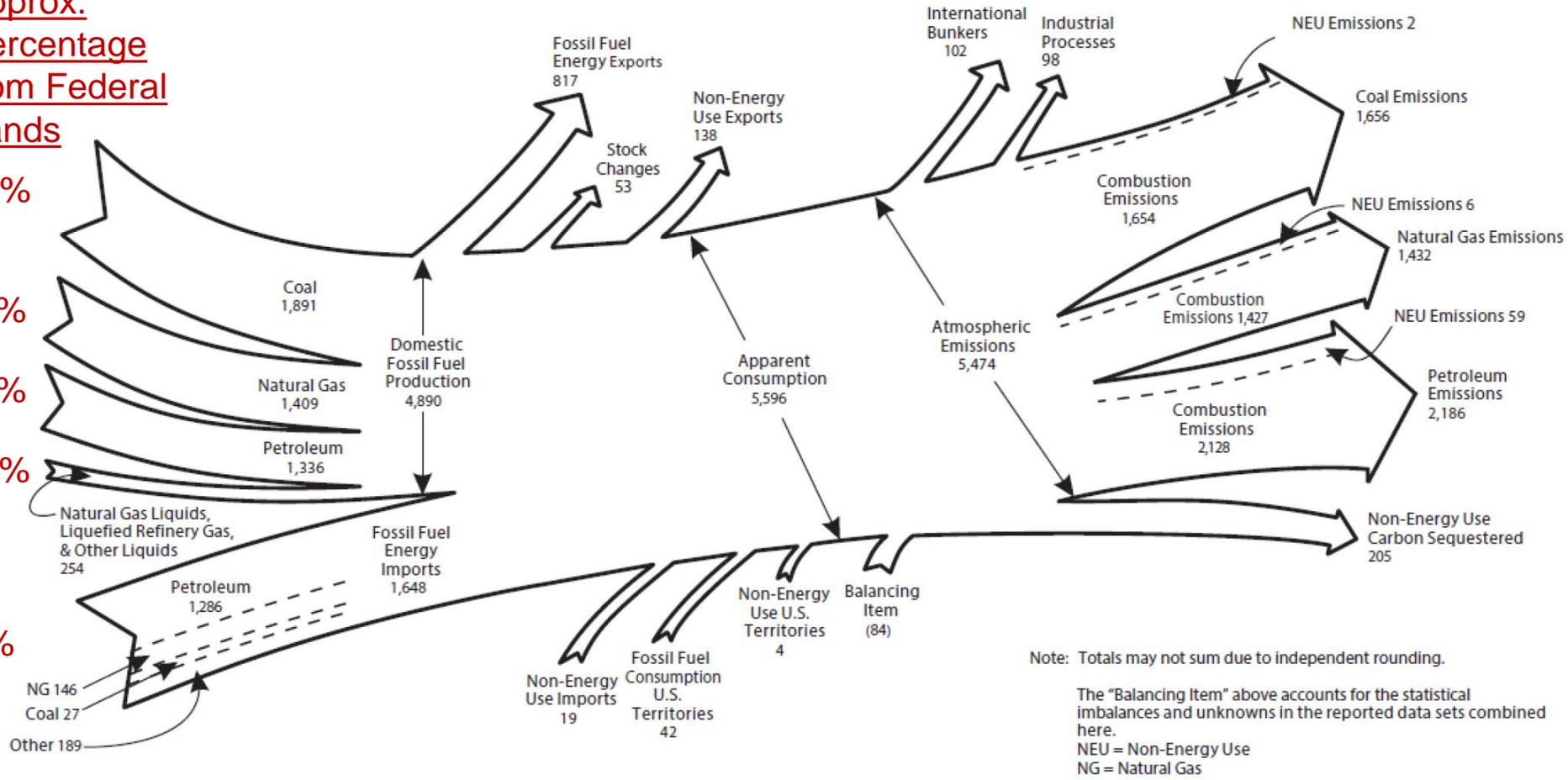
40%

14%

20%

10%

0%

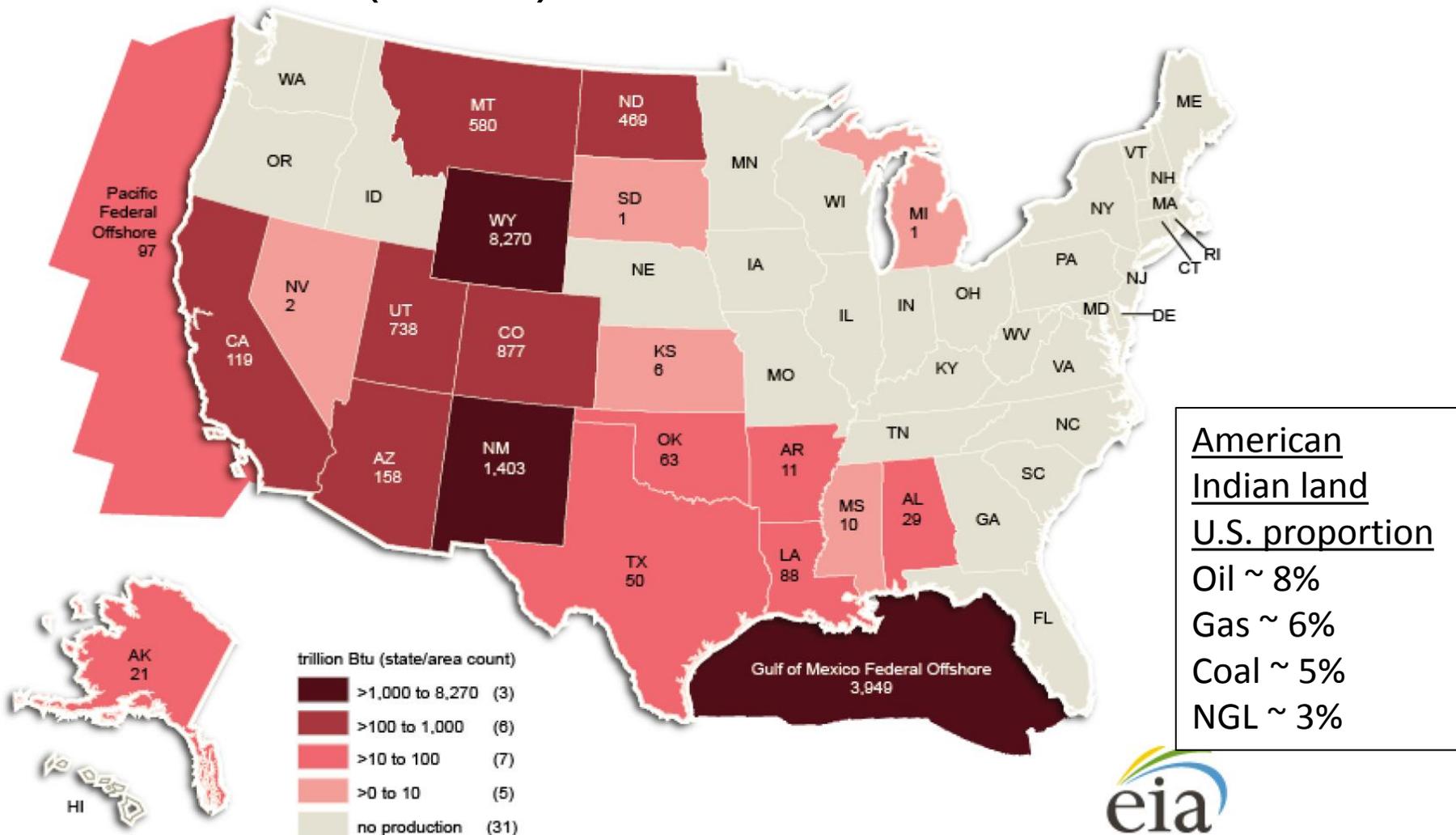


EPA (2016 Inventory, fig. 2-6)



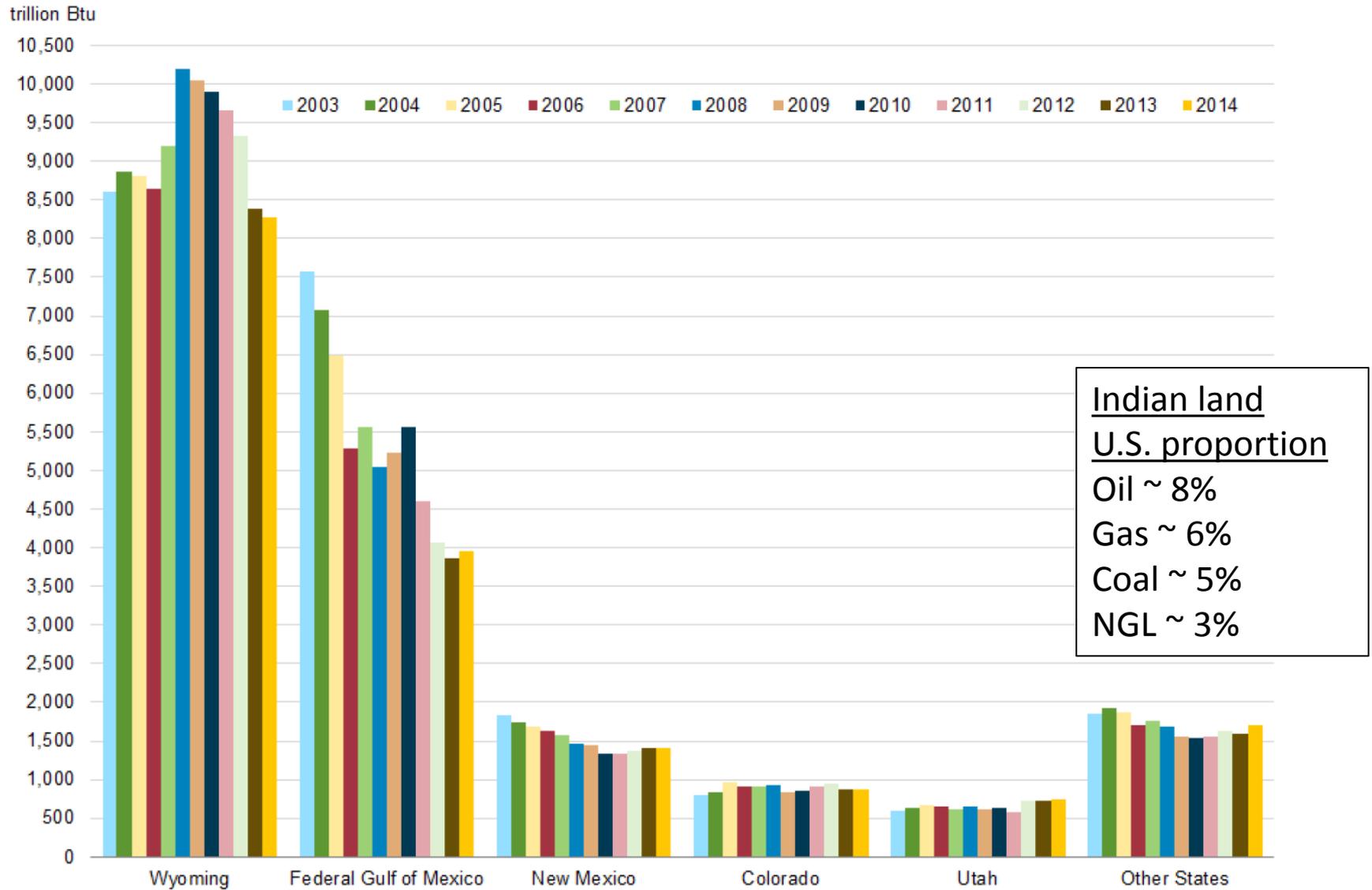
Abbreviation: Million metric tons carbon dioxide equivalent (MMT CO₂ Eq.)

Federal Lands and American Indian Lands Production (2014)



EIA (2015, fig. A-1)

Federal Lands and American Indian Lands Production



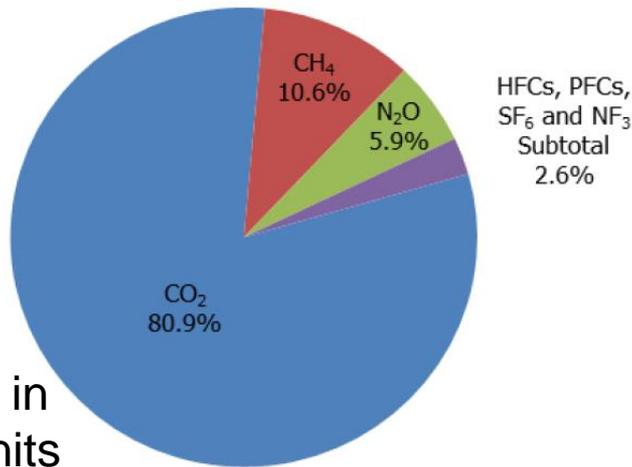
EIA (2015, fig. 4)

Comparing Emissions

- Mass in CO₂ equivalent emissions
 - Global Warming Potential (GWP)
 - Million metric tons [MMT CO₂ Eq.]

Global Warming Potentials

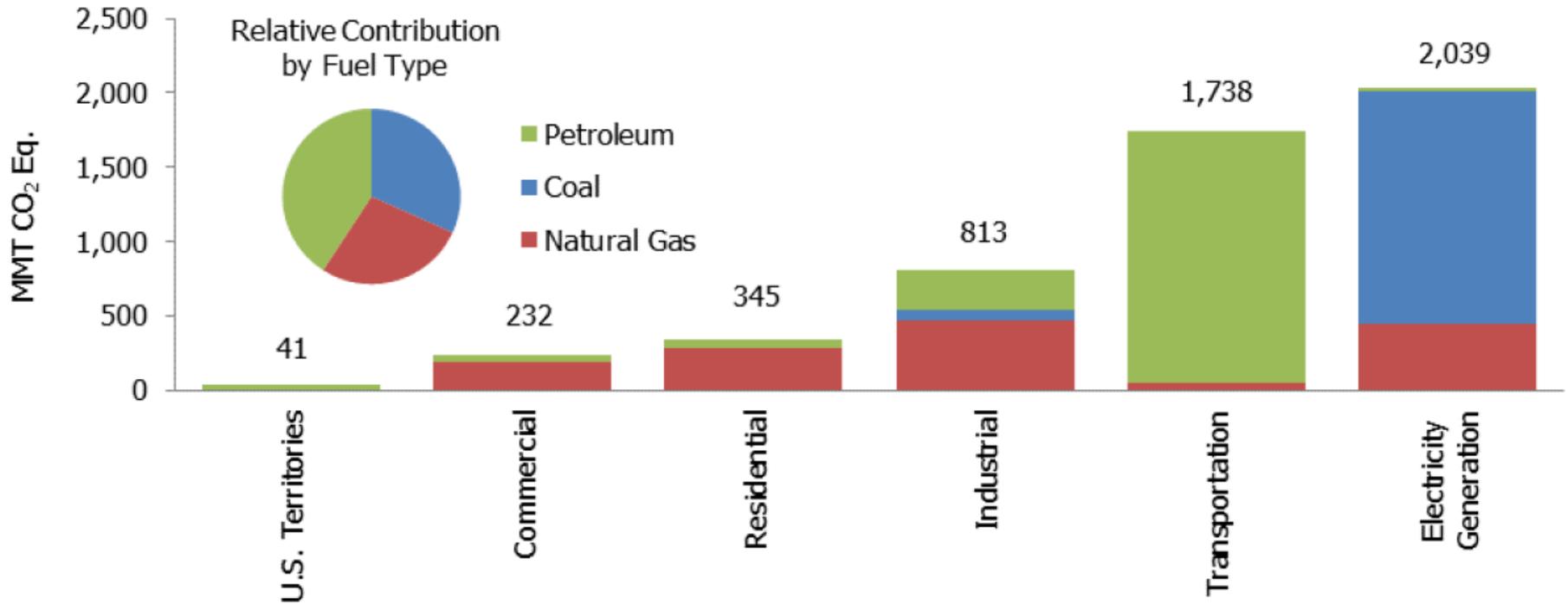
Gas	GWP
CO ₂	1
CH ₄ ^a	25
N ₂ O	298
HFC-23	14,800
HFC-32	675
HFC-125	3,500
HFC-134a	1,430
HFC-143a	4,470
HFC-152a	124
HFC-227ea	3,220
HFC-236fa	9,810
HFC-4310mee	1,640
CF ₄	7,390
C ₂ F ₆	12,200
C ₄ F ₁₀	8,860
C ₆ F ₁₄	9,300
SF ₆	22,800
NF ₃	17,200



2014 U.S. GHG Emissions by gas in CO₂ equivalent units

EPA GHG Inventory 2016

Current U.S. Emissions from Fossil Fuel Combustion by Sector (MMT CO₂ Eq.)



EPA (2016 Inventory , fig. ES-6)

USGS FLGGES Method - Status

- Test Case: State of Colorado 2014
- Active exchanges with ONRR, EPA, BLM
- Improvements goals
 - Efficiency (multiple states and years)
 - Transparency (so others can use it)
 - Clarity (so others can understand it)

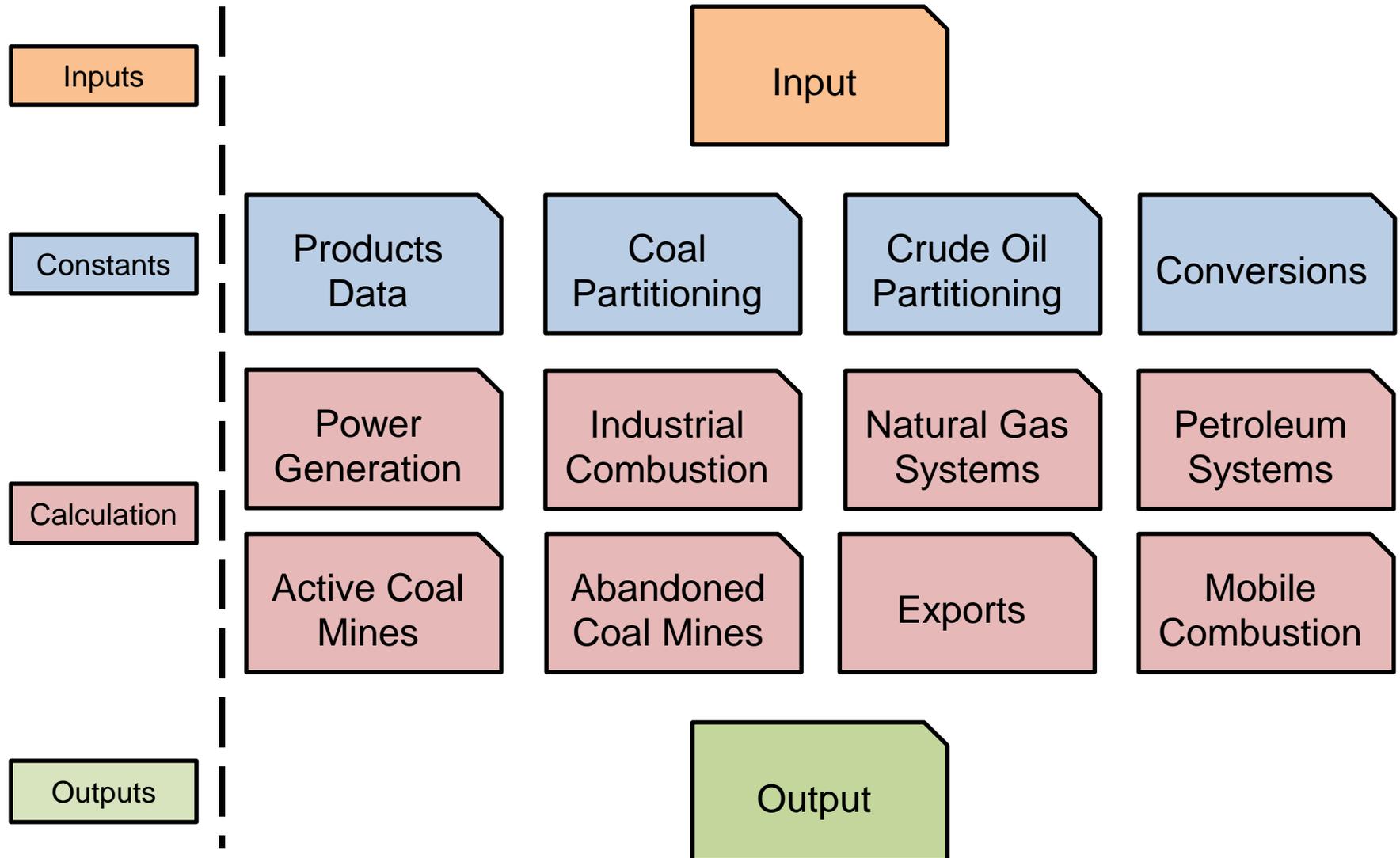
What is Included? What isn't?

National CO₂, CH₄ and N₂O Emissions from Energy (MMT CO₂ Eq.)

Gas/Source	1990	2005	2010	2011	2012	2013	2014
CO₂	4,908.8	5,932.5	5,520.0	5,386.6	5,179.7	5,330.8	5,377.9
Fossil Fuel Combustion	4,740.7	5,747.1	5,358.3	5,227.7	5,024.7	5,157.6	5,208.2
<i>Electricity Generation</i>	1,820.8	2,400.9	2,258.4	2,157.7	2,022.2	2,038.1	2,039.3
<i>Transportation</i>	1,493.8	1,887.0	1,728.3	1,707.6	1,696.8	1,713.0	1,737.6
<i>Industrial</i>	842.5	828.0	775.5	773.3	782.9	812.2	813.3
<i>Residential</i>	338.3	357.8	334.6	326.8	282.5	329.7	345.1
<i>Commercial</i>	217.4	223.5	220.1	220.7	196.7	221.0	231.9
<i>U.S. Territories</i>	27.9	49.9	41.4	41.5	43.6	43.5	41.0
Non-Energy Use of Fuels	118.1	138.9	114.1	108.5	105.6	121.7	114.3
Natural Gas Systems	37.7	30.1	32.4	35.7	35.2	38.5	42.4
Incineration of Waste	8.0	12.5	11.0	10.5	10.4	9.4	9.4
Petroleum Systems	3.6	3.9	4.2	4.2	3.9	3.7	3.6
<i>Biomass-Wood^a</i>	215.2	206.9	192.5	195.2	194.9	211.6	217.7
<i>International Bunker Fuels^a</i>	103.5	113.1	117.0	111.7	105.8	99.8	103.2
<i>Biomass-Ethanol^a</i>	4.2	22.9	72.6	72.9	72.8	74.7	76.1
CH₄	363.3	307.0	318.5	313.3	312.5	321.2	328.3
Natural Gas Systems	206.8	177.3	166.2	170.1	172.6	175.6	176.1
Petroleum Systems	38.7	48.8	54.1	56.3	58.4	64.7	68.1
Coal Mining	96.5	64.1	82.3	71.2	66.5	64.6	67.6
Stationary Combustion	8.5	7.4	7.1	7.1	6.6	8.0	8.1
Abandoned Underground Coal Mines	7.2	6.6	6.6	6.4	6.2	6.2	6.3
Mobile Combustion	5.6	2.7	2.3	2.2	2.2	2.1	2.0
Incineration of Waste	+	+	+	+	+	+	+
<i>International Bunker Fuels^a</i>	0.2	0.1	0.1	0.1	0.1	0.1	0.1
N₂O	53.6	55.0	46.1	44.0	41.7	41.4	40.0
Stationary Combustion	11.9	20.2	22.2	21.3	21.4	22.9	23.4
Mobile Combustion	41.2	34.4	23.6	22.4	20.0	18.2	16.3
Incineration of Waste	0.5	0.4	0.3	0.3	0.3	0.3	0.3
<i>International Bunker Fuels^a</i>	0.9	1.0	1.0	1.0	0.9	0.9	0.9
Total	5,324.9	6,294.5	5,884.6	5,744.0	5,533.9	5,693.5	5,746.2

EPA (2016 Inventory, table 3-1)

Calculation Worksheet Structure



Inputs

ONRR	EPA	EIA	BLM	MSHA
Oil production	Methods	Fossil fuel refining data	Well counts	Coal mine emissions
Gas production	Emission factors	Exports		
Coal production	Abandoned coal mines	Imports		
	Coal mine emissions	Fuel use by sector		
	Offshore Platforms			
	Conversions			

Abbreviations: Office of Natural Resource Revenue (ONRR); Environmental Protection Agency (EPA); Energy Information Administration (EIA); Bureau of Land Management (BLM); Mine Safety and Health Administration (MSHA).

Output

Sector	Segment	CO ₂ Emissions (MMT CO ₂ Eq.)	CH ₄ Emissions (MMT CO ₂ Eq.)	N ₂ O Emissions (MMT CO ₂ Eq.)
Stationary Combustion: Power Generation and Industrial	Coal (electric power)	✓	✓	✓
	Coal (industrial sector)	✓	✓	✓
	Coal (industrial coking)	✓	✓	✓
	Coal (commercial sector)	✓	✓	✓
	Natural gas	✓	✓	✓
	Petroleum products	✓	✓	✓
Transportation	Motor gasoline	✓	✓	✓
	Gas/diesel oil	✓	✓	✓
	Jet kerosene	✓	Not in EPA method	Not in EPA method
	Residual fuel oil	✓	Not in EPA method	Not in EPA method
	Liquified petroleum gas	✓	Not in EPA method	Not in EPA method
Petroleum Systems	Production and infrastructure	✓	✓	Not in EPA method
Natural Gas Systems	Production and infrastructure	✓	✓	Not in EPA method
Coal Mining	Surface mines	Not in EPA method	✓	Not in EPA method
	Underground mines	Not in EPA method	✓	Not in EPA method
	Abandoned mines (both)	Not in EPA method	✓	Not in EPA method
Exports	Exported fuels	✓	✓	✓

Challenges in Methodology

- Applying national proportions and ratios to state-level production.
- Efficiently determining Federal status of abandoned coal mines.
- All offshore platform emissions based on Gulf of Mexico examples.

Technical Challenges

- Inputs
 - Mixed agreements are problematic as they contain a combination of Federal, State, Indian, and Fee leases.
 - Source data, relies on inter-Agency agreements.
- Outputs
 - Results deterministic not probabilistic.
 - The calculation methods can be described but the amount of uncertainty of the results cannot be estimated in the current form.

Future

- All states with fossil fuel products from Federal lands (~38 States + offshore; for 10 data years: 2005-2014).
- Repeat each year as new data is released as well as methods improved.
- Include production data for years prior to 2005.
- Natural (non-anthropogenic) CO₂ from Federal lands not included at this time.
- Need to develop an on-line map-based data delivery tool to show Federal emissions and sequestration data by State.

Available Products

- Transparent publically available data
 - Inputs
 - All state level oil, gas and coal input data with the exception of coal production from states with one federal mine (to protect confidentiality).
 - Calculation worksheet (after peer review and USGS approvals).
 - Outputs
 - All estimated emissions data for fossil fuel products from Federal lands.
 - All states with Federal lands fuel production
 - Years 2005-2014 and onward.
 - On-line map-based data delivery tool to show Federal emissions and sequestration data by State.

Thank You

- USGS FLGGES: Emissions Team
 - Lead: Peter Warwick, pwarwick@usgs.gov
 - Methodology: Matthew Merrill, mmerrill@usgs.gov
 - Data: Philip Freeman, pfreeman@usgs.gov
- Questions to follow Biologic Sequestration presentation.
- Email one of the above for additional information.

References from Presentation

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- Environmental Protection Agency, 2004, Methane emissions from abandoned coal mines in the United States: Coalbed Methane Outreach Program, Environmental Protection Agency, 90 pages.
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- U.S. Energy Information Administration, 2015, Sales of fossil fuels produced on Federal and Indian lands FY 2003-2014: Washington D.C., U.S. Department of Energy, 36 p.
- U.S. Energy Information Administration, 2016, November 2016, Monthly energy review: Washington D.C., U.S. Department of Energy DOE/EIA-0035(2016/11), 228 p.

Appendix

Power Generation

- *Summary:* Combustion emissions from coal, natural gas and various petroleum products used in power generation.
- *Data:* ONRR production, EIA product ratios
- *Method:* EPA GHG Inventory and Annex 2016
- *Note:* ~93% of test case CO₂ emissions are from the power generation sector.

Industrial Combustion

- *Summary:* Combustion emissions from fossil fuels with storage factors to discount carbon included in the final industrial product (plastics etc.).
- *Data:* ONRR production, EIA product ratios
- *Method:* EPA GHG Inventory and Annex 2016
- *Note:* ~3% of test case CO₂ emissions are from this sector. Currently reported with Power Generation in outputs for simplicity.

Transportation/Mobile Sector

- *Summary:* Combustion emissions from various fuels used in cars, boats, trains, and airplanes.
- *Data:* ONRR production, EPA national fleet data, EIA refining ratios.
- *Method:* EPA GHG Inventory and Annex 2016
- *Note:* Assumes 1) national level emissions per gallons of fuel and 2) national vehicle fleet makeup are representative of State level emissions.

Petroleum and Natural Gas Systems

- *Summary:* All emissions from producing and refining fuels, both on and offshore.
 - Includes venting, flaring and leaking.
- *Data:* EPA emission factors, ONRR production
- *Method:* EPA GHG Inventory and Annex 2016
- *Note:* National level emissions per well are applied at State level.
 - Does not include burning the fuel or transporting it, those emissions are counted elsewhere.

Active Coal Mines

- *Summary:* Venting, captured, and post mining released methane only.
- *Data:* MSHA and EPA GHGRP data
- *Method:* EPA GHG Inventory and Annex 2016
- *Note:* Underground and surface mine specific.
 - Mine specific data is confidential and will not be released, it will be aggregated to State level.

Abandoned Coal Mines

- *Summary:* Underground mines that are vented, sealed or flooded. Methane only.
- *Data:* EPA shared data
- *Method:* EPA Abandoned Mine method
 - *Note:* Mine specific data is confidential and will not be released, it will be aggregated to State level.