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Memorandum to the Center for Biological Diversity and Friends of the Earth – USA

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Introduction

The purpose of this monograph is to present the results of an analysis of the oil, natural gas, and coal produced by private companies that have leases on Federal lands for fiscal years 2003 through 2014, and to estimate the emission of carbon dioxide that results from the marketing and end-use of the carbon fuels made available through Federal leases.

This study is commissioned by Dunkiel Saunders on behalf of the Center for Biological Diversity and Friends of the Earth–USA.

My name is Richard Heede, Director & Co-Founder of the Climate Accountability Institute. I have worked on global warming issues since 1984, published a thesis on the geography of global recoverable fossil fuels with the National Center for Atmospheric Research in 1983, worked on energy and climate policy with Rocky Mountain Institute from 1984 to 2002, established Climate Mitigation Services (a consultancy) in 2002, and co-founded (with Harvard professor Naomi Oreskes) the Climate Accountability Institute in 2011.

I have published peer-reviewed papers on climate change and emission inventories, and authored a number of publications on emission inventories on the oil and gas industry, steel industry, supply chain for liquefied natural gas supply (LNG), community inventories for cities, towns, and counties, verified inventories on behalf of corporate partners of the U.S. Environmental Protection Agency’s Climate Leaders Program, and clients in industry, non-governmental groups, and foundations. I have, over the last thirty years, developed thorough working knowledge of the protocols used by industry, governments, and municipalities to estimate emissions of greenhouse gases within well-defined boundaries. The emission inventory protocol used in this analysis is based on the best practices of corporate emission protocols adopted by industry, trade associations, and climate NGOs.¹

Data

This analysis is based on production data published annually by the U.S. Department of the Interior’s Office of Natural Resources Revenue (ONRR). The period covers 2003 through 2014. (ONRR uses the Federal fiscal year: October–September. Other data cited, such as national energy statistics from the EIA or emissions data from the EPA, are calendar years.)

Producers are required to report “sales volumes” of each fuel produced by end of the month following the month of production. Production reports are not audited. This analysis assumes that the reported quantities are accurate and complete. Emissions of CO₂ from the production of fossil fuels produced on Federal and Indian Lands, and product sales to end-users (motorists, airlines, utilities, industry, or commercial & residential building owners), are estimated from the production and sales volumes of oil, natural gas, and coal.

¹ Heede, Richard (2014) Tracing anthropogenic CO₂ and methane emissions to fossil fuel and cement producers 1854-2010, *Climatic Change*, vol. 122(1): 229-241; doi:10.1007/s10584-013-0986-y.

CAVEATS AND EXCLUSIONS: Lease holders do not report production or pay royalties on natural gas that is used in the field for electricity generation or operating field equipment; both are sources of CO₂ emissions but are not estimated (such field use is on the order of ~5 percent of natural gas produced). Natural gas produced but re-injected in oil wells for enhanced oil recovery is also excluded, since no royalties are paid to ONRR. Nor are royalties typically paid on natural gas that is flared or vented; ONRR data does show “gas lost – flared or vented” (5.5 Bcf in 2014), and this analysis quantifies CO₂ emissions on the assumption that the combined data of “flared or vented” gas is all flared (any vented produced gas would have a higher climate impact, since methane has a Global Warming Potential of 21 times CO₂ per unit of gas volume). I have not estimated fugitive emissions of methane from coal mining or natural gas production or pipelines (including methane would add ~8.5 percent and ~20.7 percent to emissions from coal and natural gas production, respectively, on a CO₂-equivalent basis (CO₂e)).

Vented CO₂ from the processing of natural gas to meet pipeline specifications is not estimated. The use of “own fuel” such as natural gas used in drilling operations, on offshore production platforms, and in pipeline compressor stations is excluded — as is fuel, chiefly diesel fuel, used in transportation and other equipment used to operate drill rigs, trucks, pumping, and injection equipment. The exclusions listed above would, if included, add ~6.0 percent to the combustion of oil & liquids as estimated below, ~29.5 percent to natural gas, and ~8.5 percent to coal.

Methodology

A peer-reviewed methodology for estimating emissions of CO₂ to the atmosphere of crude oil and other liquid fuels, natural gas and coal bed methane, and coal is applied to the ONRR fossil fuel sales data for each year.

COAL: Coal is reported in short tons per year for production on Federal Onshore and Indian Lands. Coal production is *not* reported by coal rank; accounting for the rank of coal mined is important in estimating emissions. I have therefore analyzed reported production of coal on Federal Lands by state (Table 1) and calculated each state’s production of coal by rank using data reported by the Energy Information Administration for each state.

Table 1. Coal production by coal rank in states with ONRR coal leases, 2012.

State	Total state Bituminous million tons	Total state Sub-bituminous million tons	Total state Lignite million tons	ONRR 2012 million tons
Alabama	19.32			2.33
Colorado	20.57	8.00		19.11
Kentucky	90.86			0.23
Montana	5.71	30.69	0.30	23.48
New Mexico	14.83	7.62		4.71
North Dakota			27.53	3.92
Oklahoma	1.05			0.45
Utah	17.02			13.37
Wyoming		401.44		374.25
Indian Lands				21.61
Sum of states	169.36	447.75	27.83	441.84
Total U.S. prod’n	485.36	449.80	78.93	na

Sources: EIA coal production by state and total US; US total 2012: 1,016 million short tons; ONRR for 2012.

The percentages generated from the coal produced in each state in Table 1 is applied to total coal mined in each state under ONRR leases. Estimated emissions by coal rank for each state is calculated using the emission factors in Table 2. Coal produced under leases on Indian Lands is not reported by state in ONRR data (19 million tons in 2012), and the average emission factor for U.S. thermal coal is applied in estimating emissions.

Table 2. Combustion emission factors (also account for non-energy uses)

Energy source	Carbon tC/unit	Carbon dioxide tCO₂/unit
Crude oil & NGLs	101.4 kgC/bbl	371.4 kgCO ₂ /bbl
Natural gas	14.6 kgC/kcf	53.4 kgCO ₂ /kcf
Lignite	328.4 kgC/tonne	1,203.5 kgCO ₂ /t
Subbituminous	495.2 kgC/t	1,814.4 kgCO ₂ /t
Bituminous	665.6 kgC/t	2,439.0 kgCO ₂ /t
Anthracite	715.6 kgC/t	2,621.9 kgCO ₂ /t
“Metallurgical coal”	727.6 kgC/t	2,665.9 kgCO ₂ /t
“Thermal coal”	581.1 kgC/t	2,129.3 kgCO ₂ /t

Crude oil: prior to non-energy deduction & adjustment for NGLs: 115.7 kgC/bbl, 423.8 kgCO₂/bbl;
 Gas: prior to non-energy deduction: 14.86 kgC/kcf, or 54.44 kgCO₂/kcf; (kcf = thousand cubic feet).

CRUDE OIL & OTHER HYDROCARBON LIQUIDS PRODUCTION: ONRR reports royalty production on Federal Lands for Offshore and Onshore areas by type of product. The largest reported quantities are crude oil (518 million bbl in 2014), condensate (45 million bbl), and gas plant products (109 million bbl), and smaller quantities of scrubber condensate, sweet crude, etc. Each of these products differ in emissions per bbl: natural gas liquids (NGLs) has an emission factor of ~250 kgCO₂/bbl, whereas crude oil emission factor is 432 kgCO₂/bbl. The methodology adopted for this analysis adjusts the combined crude oil and liquids emission factor from 432 kgCO₂/bbl to 404 kgCO₂/bbl to account for the proportion of lighter liquids such as NGLs and condensates. Significant non-energy uses of petroleum products — for petrochemicals, lubricants, waxes, and road oil (asphalt) — reduces the emission factor to 371.4 kgCO₂/bbl (Table 2). This adjustment is made to account for non-energy uses that sequester a proportion of petroleum products away from the atmosphere.

NATURAL GAS AND COAL BED METHANE: The majority of natural gas production on Federal Lands is reported as processed and unprocessed gas, flowed by coal bed methane from onshore coal regions. Quantities of Non Revenue produced gas are also reported. Pipeline quality natural gas has a fairly constant carbon factor of 54.4 metric tonnes CO₂ per billion cubic feet (Bcf) (54.4 tCO₂/Bcf). The emission inventory protocol accounts for relatively minor non-energy uses of natural gas, such as for fertilizer production, which reduces the emission factor to 53.4 tCO₂/Bcf.

Results

Fossil fuel production on Federal and Indian Lands, including offshore regions, has been a relatively constant proportion of fuel total oil, gas, and coal produced in the United States over the 2003-2014 period — ~75-78 percent of which is on private lands, and ~22-25 percent on Federal and Indian Lands; see Tables 3 and 4 and Figure 1.

Table 3. Coal, oil, and natural gas produced on Federal and Indian Lands, 2003-2014.

Year	Coal		Oil & liquids		Natural Gas & CBM	
	Federal Mt	Indian Mt	Onshore Mbbbl	Offshore Mbbbl	Onshore Bcf	Offshore Bcf
2003	436	30	142	629	2,275	4,522
2004	451	33	138	635	2,351	4,025
2005	447	34	136	597	2,534	3,523
2006	429	29	140	517	2,619	2,754
2007	443	27	148	573	2,857	2,700
2008	483	26	153	515	3,049	2,483
2009	462	26	152	589	3,167	2,213
2010	457	22	181	674	3,006	2,080
2011	447	22	192	584	2,896	1,692
2012	442	19	210	521	2,887	1,374
2013	401	19	200	522	2,637	1,198
2014	402	19	218	549	2,482	1,069

Mt = million short tons; Mbbbl = million bbl; Bcf = billion cubic feet. CBM = coal bed methane.

In 2014, two-fifths (40.2 percent) of U.S. coal production was from leases on Federal Lands; production on Indian Lands accounted for an additional 1.9 percent of U.S. coal production. One-quarter of total U.S. oil and NGL production was from Federal Onshore and Offshore regions in 2014, though production from Federal onshore and offshore reached 43 percent in 2010. The lion's share of ONRR production is from offshore (549 million bbl offshore, and 218 million bbl onshore). ONRR production of natural gas fell from 36 percent of total U.S. production in 2003 to 14 percent in 2014, and 70 percent of ONRR gas production is from Federal Onshore.

Table 4. Coal, oil, and natural gas produced on Federal and Indian Lands, and total U.S. production, 2003-2014.

Year	Coal		Oil & liquids		Natural Gas & CBM	
	ONRR Mt	U.S. total Mt	ONRR Mbbbl	U.S. total Mbbbl	ONRR Bcf	U.S. total Bcf
2003	466	1,072	772	2,062	6,798	19,099
2004	484	1,112	773	1,991	6,376	18,591
2005	482	1,131	734	1,891	6,057	18,051
2006	458	1,163	656	1,857	5,373	18,504
2007	471	1,147	721	1,853	5,557	19,266
2008	509	1,172	668	1,830	5,532	20,159
2009	488	1,075	741	1,953	5,380	20,624
2010	478	1,084	855	2,001	5,086	21,316
2011	470	1,096	776	2,060	4,588	22,902
2012	461	1,016	731	2,378	4,261	24,033
2013	420	985	722	2,724	3,835	24,334
2014	421	1,000	767	3,168	3,551	25,718

Mt = million short tons; Mbbbl = million bbl; Bcf = billion cubic feet. CBM = coal bed methane.

Emissions traced to production on Federal and Indian Lands range from a high of 1.46 billion tonnes of carbon dioxide (GtCO₂) in 2004 to a low of 1.19 GtCO₂ in 2013 and 2014; see Tables 5 and 6.

This analysis estimates emissions of carbon dioxide from the fossil fuel resources produced on Federal and Indian Lands and subsequently marketed to end-use consumers in the United States or to export markets (there is a growing export market for coal and natural gas in the form of liquefied natural gas (LNG)). This analysis does not account for or exclude carbon fuel exports. It quantifies the emissions from fuels produced on Federal Lands, after deducting for non-energy uses of petroleum products (which sequesters carbon in products such as petrochemicals, asphalt, and lubricants), regardless of whether the produced fuels are combusted in the United States or internationally.

Table 5. CO₂ emissions from coal, oil, and natural gas produced on Federal Offshore, Federal Onshore, and Indian Lands, 2003-2014.

Year	Federal Offshore MtCO ₂	Federal Onshore MtCO ₂	Indian Lands MtCO ₂	Total ONRR MtCO ₂
2003	475	913	58	1,446
2004	451	941	63	1,455
2005	410	944	66	1,421
2006	339	916	56	1,311
2007	357	953	53	1,363
2008	324	1,030	50	1,404
2009	337	1,001	50	1,388
2010	362	996	42	1,399
2011	307	976	43	1,326
2012	267	975	37	1,278
2013	258	890	37	1,185
2014	261	889	36	1,186

MtCO₂: million metric tonnes CO₂/yr.

This analysis is conservative overall, insofar as fuels produced on Federal Lands but used by the lessees in on-site generation or other equipment are not included in the ONRR production data. This analysis also excludes venting of process CO₂ and fugitive methane — significant sources that are not tracked in ONRR production data.

Table 6. CO₂ emissions from coal, oil, and natural gas produced on Federal and Indian Lands, onshore plus offshore, 2003-2014, and total U.S. fossil fuel emissions.

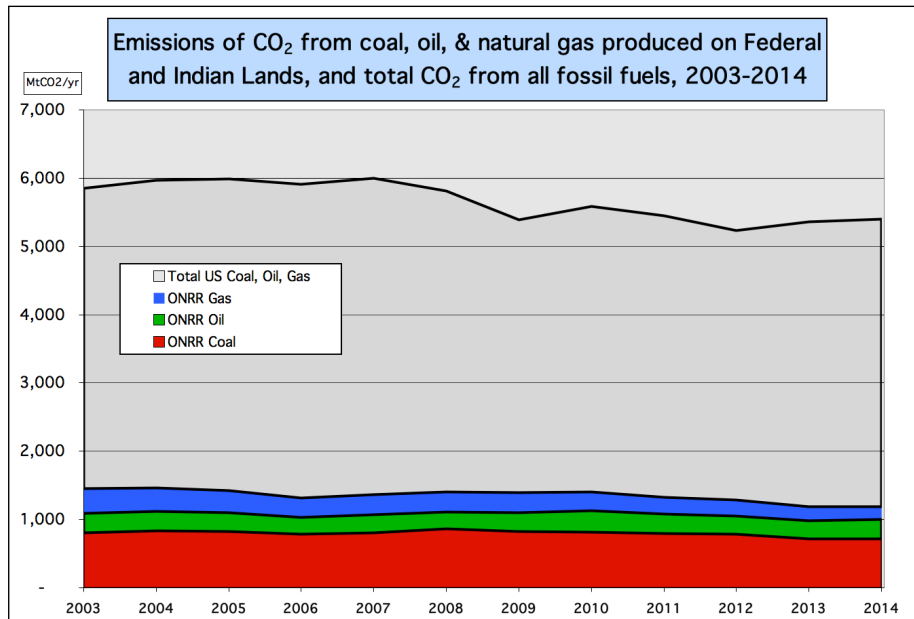
Year	Coal MtCO ₂	Oil & liquids MtCO ₂	Natural Gas & CBM MtCO ₂	Total ONRR MtCO ₂	Total U.S. MtCO ₂
2003	796	287	363	1,446	5,853
2004	827	287	341	1,455	5,970
2005	824	273	324	1,421	5,993
2006	781	244	287	1,311	5,910
2007	798	268	297	1,363	6,001
2008	861	248	296	1,404	5,809
2009	825	275	287	1,388	5,386
2010	810	318	272	1,399	5,582
2011	792	288	245	1,326	5,445
2012	779	272	228	1,278	5,232
2013	711	268	205	1,185	5,362
2014	712	285	190	1,186	5,414
2003-2014	9,560	3,312	3,334	16,206	67,957

MtCO₂: million metric tonnes CO₂/yr. CBM: coal bed methane. Heede calculations from ONRR data. Total U.S.: EIA.

Discussion

Using data from the Department of the Interior’s Office of Natural Resources Revenue (ONRR), I have traced reported production of coal, oil & other liquids (such as condensates and gas plant liquids), and natural gas (including coal bed methane) from 2003 to 2014. Emissions of carbon dioxide have been estimated based on combustion of carbon fuels supplied to domestic and international consumers. The analysis deducts for estimated non-energy uses of carbon products (such as for petrochemicals, fertilizers, lubricants, asphalt). The analysis excludes several sources of emissions, such as ubiquitous flaring, vented CO₂ from natural gas processing, lease holders’ field use of produced fuels, and all methane emissions that would have, based on my analysis, added 6.0 percent to the combustion of oil and liquids, 29.5 percent to natural gas, and 8.5 percent to coal.

Figure 1. Sum of CO₂ emissions from coal, oil, and natural gas produced on Federal and Indian Lands, compared to total U.S. emissions from fossil fuels, 2003-2014.



Source: Climate Accountability Institute. ONRR oil, gas, and coal emissions are additive.

Estimated emissions from fossil fuel production on Federal Lands, including Indian Lands, is consistently 22 to 26 percent of U.S. emissions from the consumption of all oil, natural gas, and coal over the period from 2003 to 2014 (Figure 1). The average contribution from 2003 to 2014 is 23.8 percent of total U.S. emissions from the consumption of oil, natural gas, and coal (table 6: emissions attributed to fuels produced on Federal and Indian lands 2003-2014 totals 16,206 MtCO₂, of total U.S. fossil fuel emissions of 67,957 MtCO₂).

Respectfully,

Richard Heede
 Director, Climate Accountability Institute