Colorado Greenhouse Gas Inventory 2014 Update Including Projections to 2020 & 2030

October 16, 2014

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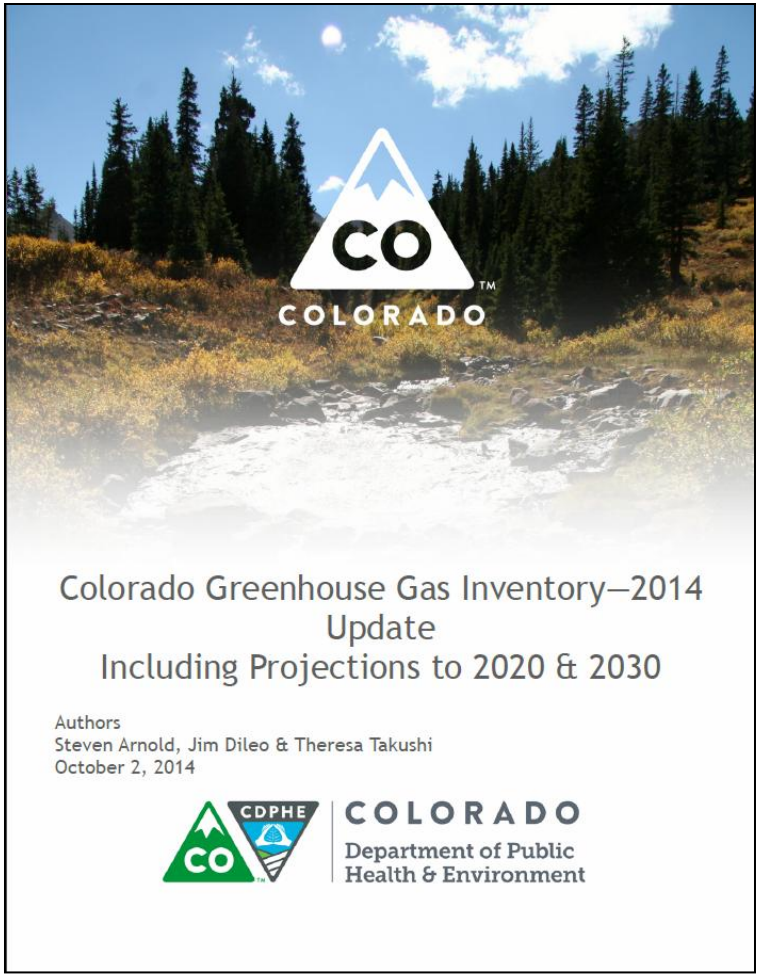
Overview

- Background
- Process to Develop Inventory
- Explanation of the Model
- Inventory Results
- Stakeholder Concerns
- Recommendations



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Background

- Background
  - Executive Order (EO) #D 004 08
  - April 22, 2008
  - Governor Bill Ritter, Jr.
  - directed CDPHE to perform updates to the state's greenhouse gas emissions inventory every five years

Process To Develop Inventory

- Preparation
- Drafting
- Draft Issued (December 2013)
- Public Comment Period
- Final Version Issued

Process To Develop Inventory

- Final includes a combined top-down & bottom up approach
- Detailed description of the methodology used
- State Inventory Tool (SIT) – model used
  - Links major national data bases to calculation schemes
  - Has consistency with other states
  - Follows the international GHG protocol the U.S. agreed to follow for the national inventory
  - Allows for customization of emission factors and activity assumptions
  - Was updated by EPA in 2013 to improve the process using latest assumptions

Process To Develop Inventory

- Final relies mostly on SIT Model default values, with the exception of O&G
- SIT Model allows customization to either better reflect Colorado's emissions or test alternative scenarios
  - Challenges with Projection Tool
- As a general rule inventory presents data as organized by model, but limited reorganization done to provide a more cohesive sector based analysis of GHG emissions in Colorado

Layout of the Document

- Executive Summary
- Synthesis Chapter
  - Summarizes the results from entire model for the period from 1990-2010
- Projection Chapter
  - Summarizes the results from the projection module (2011-2030)
- Individual Chapters for Each Sector

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Sectors

- Electrical Power
- Residential, Commercial, Industrial (RCI) Fuel Use
- Transportation
- Industrial Processes
- Coal Mining and Abandoned Mines
- Gas Production
- Agriculture
- Waste Management
- Forestry and Land Use

Explanation of the Model

Chapter 1. Synthesis Tool • Combines results of all SIT Modules for total CO_2e Emissions 1990-2010
Chapter 2. Projection Tool • Projections of CO_2, N_2O and CH_4 for all sectors from 2011-2030 using 1. Energy Consumption Projection 2. Greenhouse Gas Estimates, 1990-2030 Inventory Tool
Chapter 3. Electrical Power • CO_2 from Fossil Fuel Combustion Module • N_2O and CH_4 from Stationary Combustion Module • Indirect CO_2 Emissions
Chapter 4.Residential, Commercial, Industrial (RCI) Fuel Use • CO_2 from Fossil Fuel Combustion Module • N_2O and CH_4 from Stationary Combustion Module
Chapter 5. Transportation • CO_2 from Fossil Fuel Combustion Module • N_2O and CH_4 from Mobile Combustion Module
Chapter 6. Industrial Processes • CO_2, N_2O, HFC, PFC, and SF_6 Industrial Processes Module
Chapter 7. Coal Mining • CH_4 from Coal Mining & Abandoned Mines Module
Chapter 8. Gas Production • CH4 from Natural Gas and Oil Systems Module
Chapter 9. Agricultural Methane and Nitrous Oxide • N_2O and CH_4 from Agricultural Module
Chapter 10. Waste Management • CO_2, N_2O and CH_4 from Municipal Solid Waste Module • N_2O and CH_4 from Wastewater Module
Chapter 11. Land Use and Forestry • CO2, N2O and CH4 from Land Use, Land Use Change and Forestry Module Emissions and Sinks

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Explanation of the Model

- Electrical Power
  - CO_2 from Fossil Fuel Combustion Module
  - N_2O and CH_4 from Stationary Combustion Module
  - IndirectCO_2 Emissions

- Transportation
  - CO2 from Fossil Fuel Combustion Module
  - N2O and CH4 from Mobile Combustion Module

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Explanation of the Model

- Residential, Commercial, Industrial (RCI) Fuel Use
  - CO_2 from Fossil Fuel Combustion Module
  - N_2O and CH_4 from Stationary Combustion Module

- Industrial Processes
  - CO2, N2O, HFC, PFC, and SF6 Industrial Processes Module

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Explanation of the Model

- Coal Mining
  - CH_4 from Coal Mining & Abandoned Mines Module
- Gas Production
  - CH4 from Natural Gas and Oil Systems Module
- Agricultural Methane and Nitrous Oxide
  - N2O and CH4 from Agricultural Module

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Explanation of the Model

- Waste Management
  - CO_2, N_2O and CH_4 from Municipal Solid Waste Module
  - N_2O and CH_4 from Wastewater Module

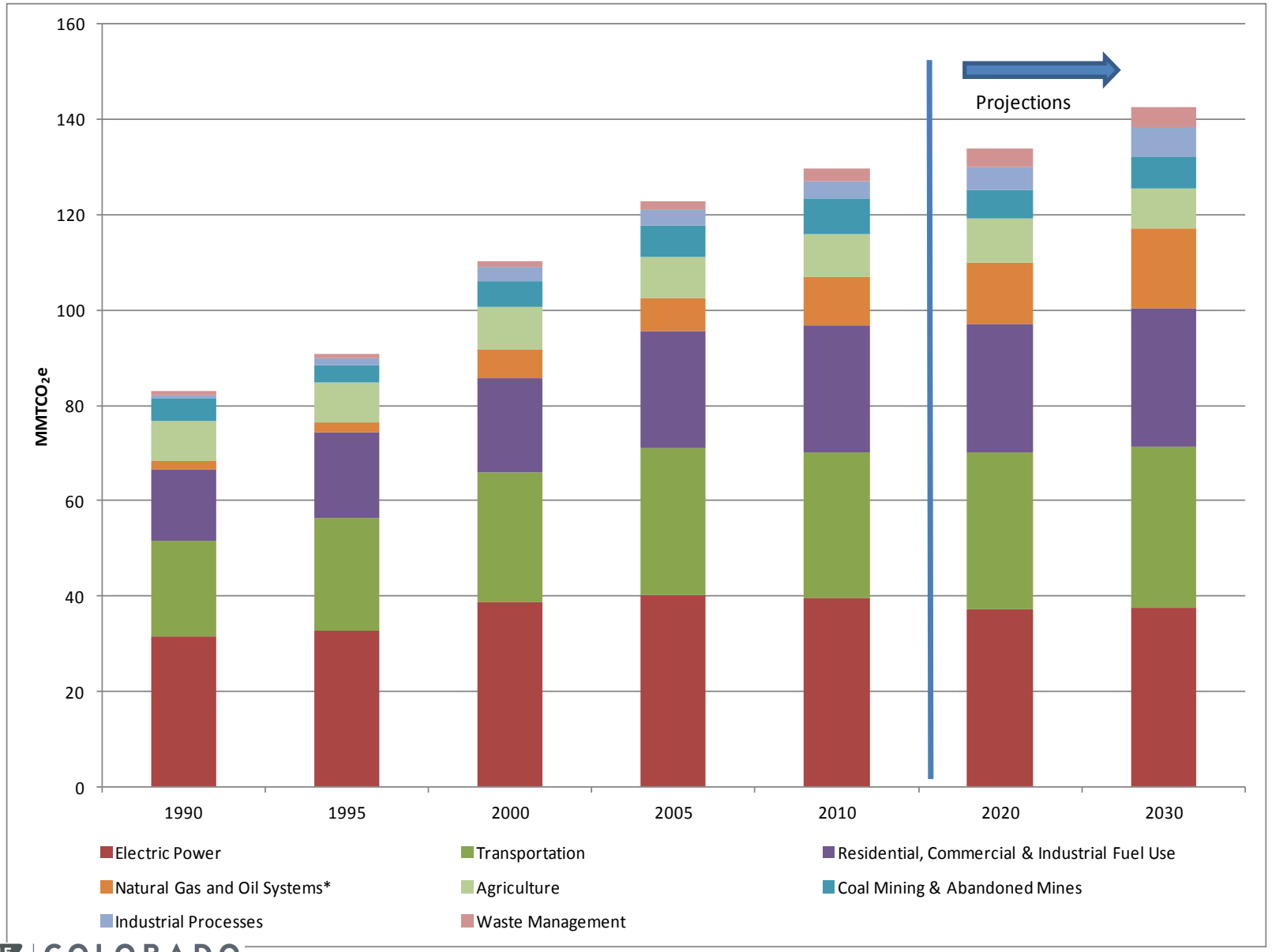
- Land Use and Forestry
  - CO2, N2O and CH4 from Land Use, Land Use Change and Forestry Module Emissions and Sinks

Explanation of the Model

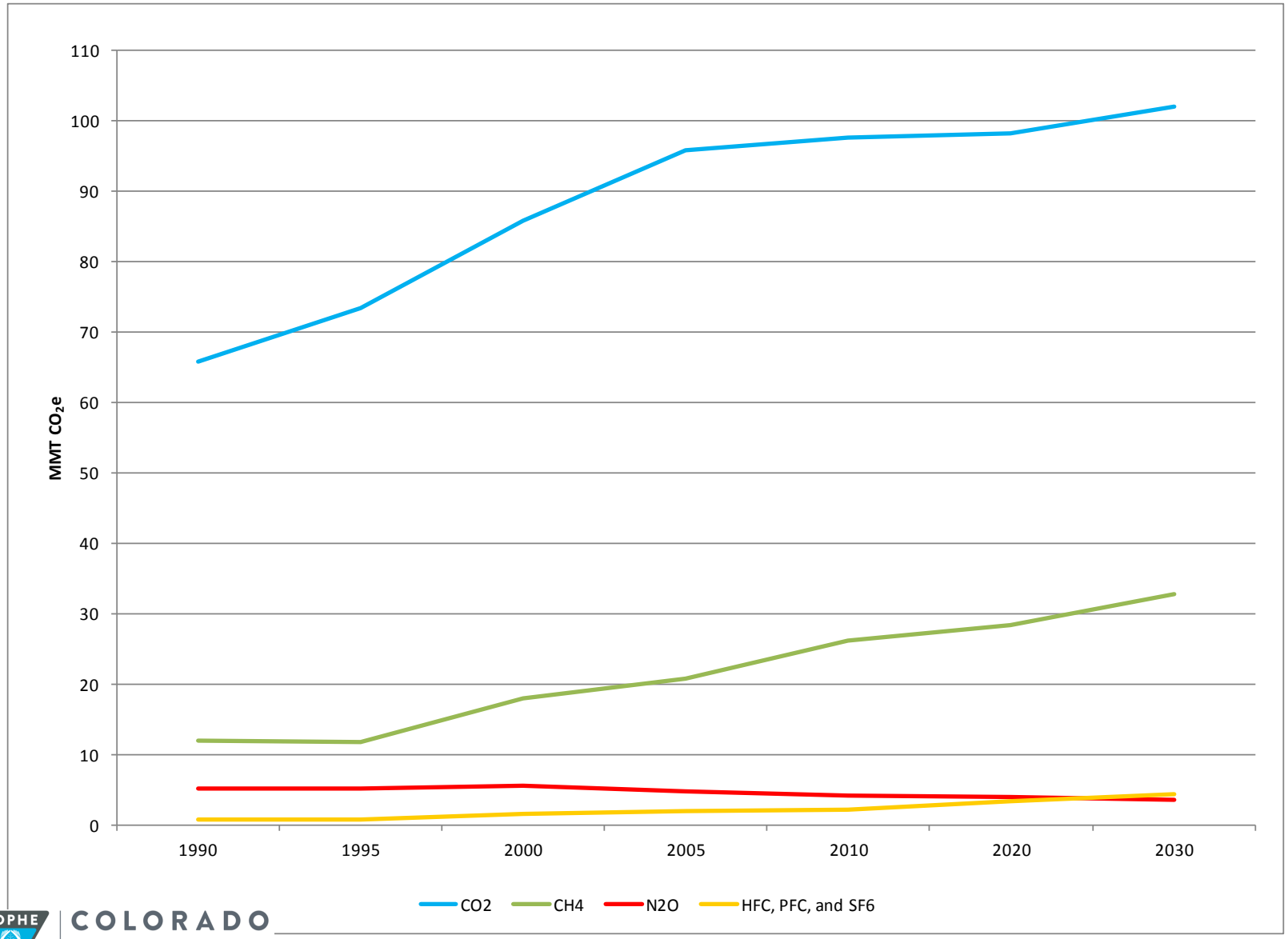
- Synthesis Tool
  - Combines results of all SIT Modules for total CO_2e Emissions 1990-2010

- Projection Tool
  - Projections of CO_2, N_2O and CH_4 for all sectors from 2011-2030 using
    1. Energy Consumption Projection
    2. Greenhouse Gas Estimates, 1990-2030 Inventory Tool

Summary of Colorado GHG Emissions by Emission Sector (MMTCO2e) SIT Model Runs 1990-2030



Trend in Historical and Projected Colorado GHG Emission by Gas (MMTCO2e)



Global Warming Potential (GWP) Carbon Dioxide Equivalent (CO2e)

GHG		GWP		CO2e
CO2	X	1	=	1 CO2e
CH4	X	21	=	21 CO2e
N2O	X	310	=	310 CO2e
HFC	X	17,200	=	17,200 CO2e
PFC	X	17,340	=	17,340 CO2e
SF6	X	23,900	=	23,900 CO2e
GHG				Total GHG CO2e

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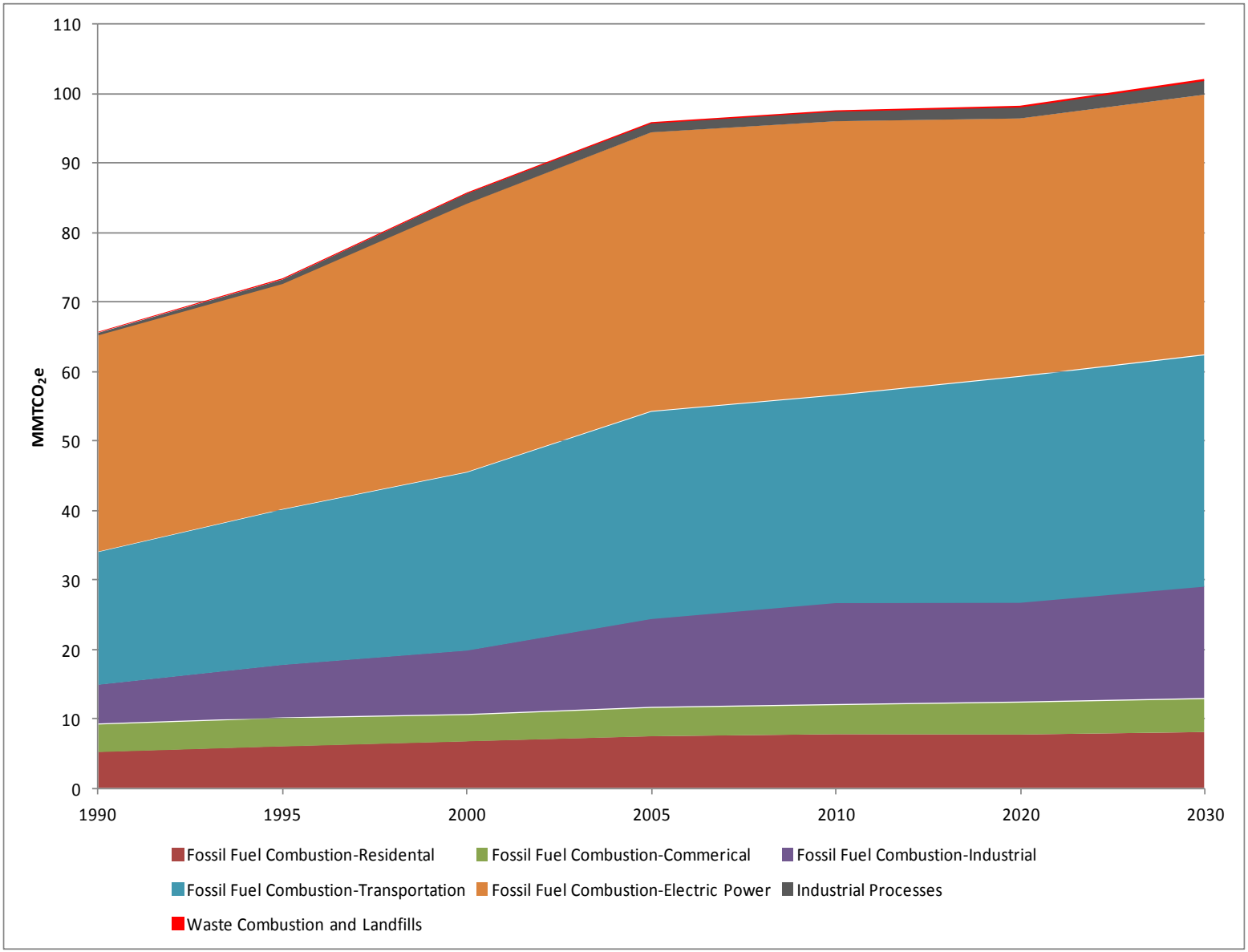
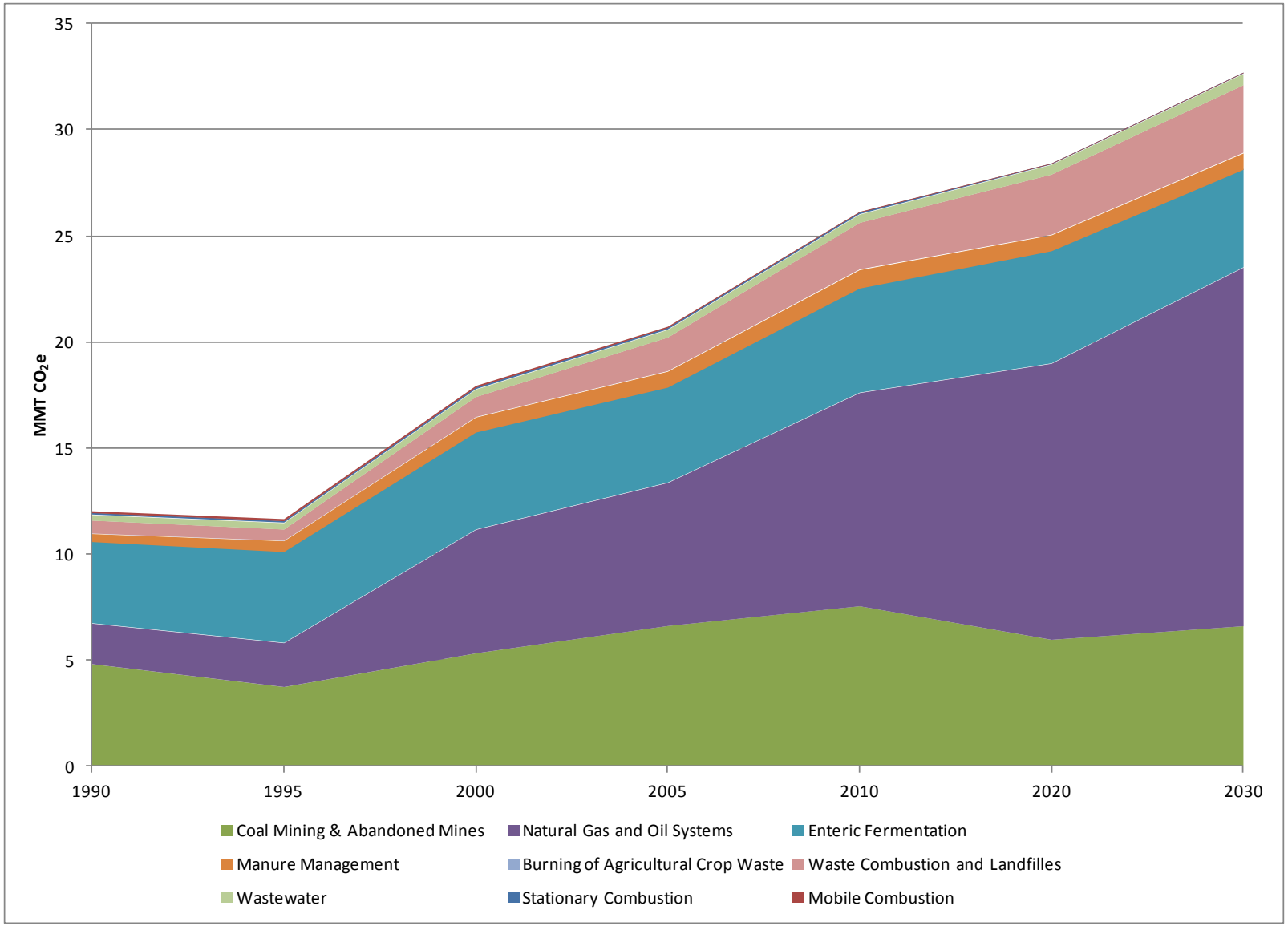
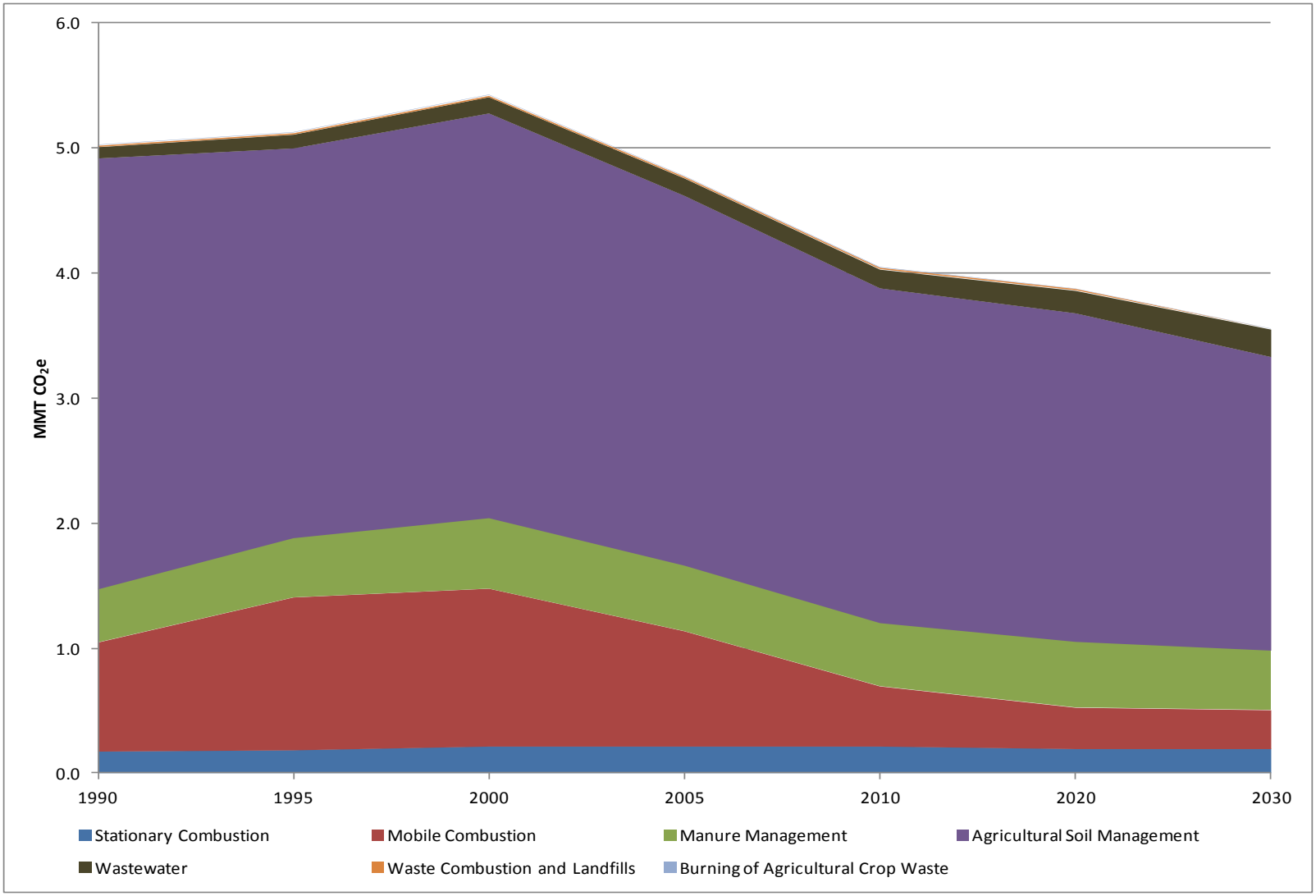
Trend in Colorado Emissions Carbon Dioxide by Source Category (MMTCO2e)



Trend in Colorado Methane Emissions by Source Category (MMTCO2e)



Trend in Colorado Nitrous Oxide GHG Emissions by Source Category (MMTCO2e)



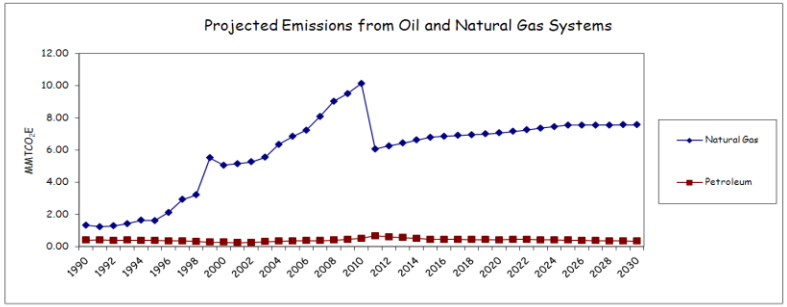
Examples of Data Used – Transportation

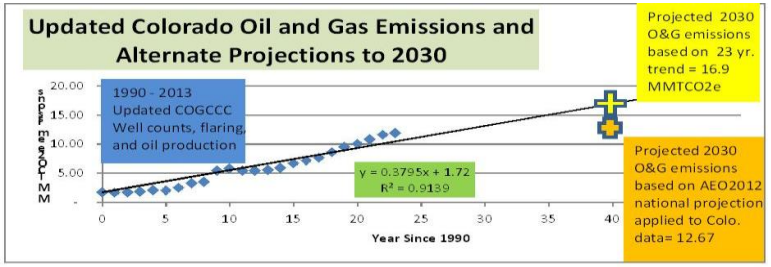
- 1990-2010
  - CO_2 emission factor times the amount of fuel used in each transportation sector per year
  - CH_4 and N_2O emissions factors multiplied by vehicle miles of travel for each vehicle type per year
- Projections
- 2010 Colorado fuel use apportioned to Annual Energy Outlook projection

Examples of Data Used – Oil and Gas

- 1990-2010
- NG Production -Well counts X CH4 emission factor/well
  - 5,912 wells in 1990 x 9.59 mtCH4/yr
  - 52,182 wells in 2014 x 10.62 mtCH4/yr
- Add in Venting & Flaring
  - BBTU vented x 80% flared x 54.71 $MtCO_2$/BBTU produced per year
  - 20% vented
- Add Oil Production based on volume produced x Emission Factor

- Projections
  - Sum of emissions from O&G plotted from 1990-2013
  - Linear regression derived from 23 year trend projected to 2030





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Modifications made to the Oil and Gas Sector

Year	SIT Module Well count	Default SIT Emissions $MMTCO_2e$	COGCC Well Counts	SIT Emissions Using COGCC Well Counts	% difference (Alter - default/ default)
1990	5,741	1.09	Not avail.	1.32	21%
1991	5,562	1.09	Not avail.	1.23	12.80%
1992	5,912	1.19	Not avail.	1.28	7.60%
1993	6,372	1.32	Not avail	1.42	7.50%
1994	7,056	1.51	Not avail	1.63	7.90%
1995	7,017	1.54	Not avail	1.61	4.50%
1996	8,251	2.06	Not avail	2.12	2.60%
1997	12,433	2.82	Not avail	2.93	3.50%
1998	13,838	3.14	Not avail	3.2	1.90%
1999[a]	13,838[a]	3.14	Not avail	5.13	63.0%[a]
2000	22,442	5.08	24,126	5.5	1.20%
2001	22,117	4.97	22,190	5.15	2.80%
2002	23,554	5.27	22,742	5.14	0.90%
2003	18,774	4.19	23,300	5.26	31.00%
2004	16,718	3.73	24,589	5.54	68.60%
2005	22,691	5.06	28,164	6.34	34.00%
2006	20,568	4.59	30,135	6.78	56.20%
2007	22,949	5.12	32,135	7.23	56.60%
2008	25,716	5.74	35,978	8.1	56.10%
2009	27,021	6.03	40,184	9.03	56.60%
2010	28,813	6.43	42,324	9.49	56.60%

rom year to year ranging from 9.07 in for the years 2005-2010.

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Examples of Data Used – Electricity

- 1990-2010
  - Fossil fuel use by type for each year multiplied by fuel specific emission factors for CO_2, N_2O, and CH_4
  - Emissions totaled by year
- 2011-2030 Projections
  - Projected fossil fuel consumption data table, by fuel type, built by default model by apportioning national fuel use to Colorado
  - Calculation by year based on same factors used in base case

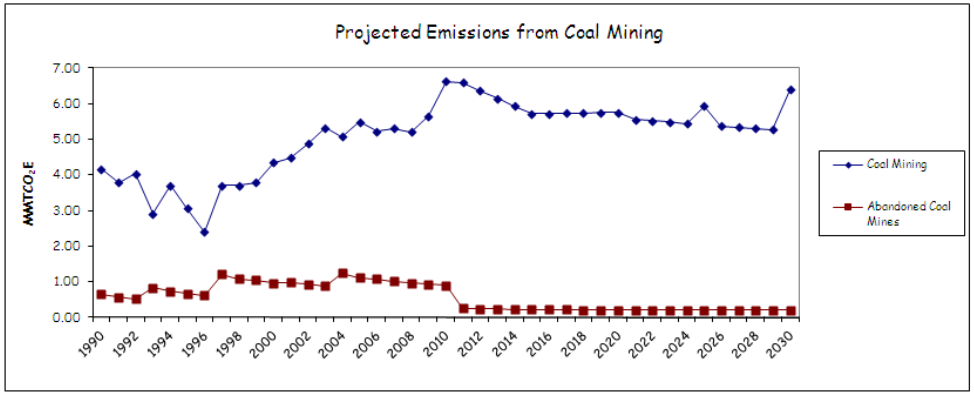
Power Plant Data Considered

Facility Name	2012 Reporting Rule (metric tons CO2e)	2012 CAMD* (converted to metric tons CO2e)
CRAIG	9,038,891	8,970,226
COMANCHE (470)	8,859,819	8,811,988
PAWNEE	3,394,721	3,374,582
CHEROKEE	3,062,597	3,045,857
HAYDEN	2,642,886	2,628,270
RAWHIDE ENERGY STATION	2,069,282	2,053,452
MARTIN DRAKE	1,619,283	1,607,339
RAY D NIXON	1,536,800	1,524,884
FORT ST. VRAIN	1,420,793	1,409,972
VALMONT	1,094,731	1,086,600
ARAPAHOE	1,032,702	1,027,377
ROCKY MOUNTAIN ENERGY CENTER	1,016,496	1,015,505
NUCLA	673,661	667,975
FRONT RANGE POWER PLANT	559,624	559,078
J.M. SHAFER GENERATING STATION	404,838	404,105
PUEBLO AIRPORT GENERATING STATION	317,683	317,373
SPINDLE HILL ENERGY CENTER	169,070	167,881
FOUNTAIN VALLEY POWER PLANT	145,515	144,744
MANCHIEF GENERATING STATION	103,575	103,239
BLUE SPRUCE ENERGY CENTER	100,452	100,304
LIMON GENERATING STATION	95,555	94,983
ARAPAHOE COMBUSTION TURBINE FACILITY	43,791	43,715
ZUNI	28,338	28,310
BRUSH POWER PROJECTS	42,290	19,909
FRANK KNUTSON STATION	6,662	6,603
VALMONT COMBUSTION TURBINE FACILITY	910	909
Subtotal of CAMD Units	**39,480,965**	**39,215,180**
AQUILA, INC. - AIRPORT INDUSTRIAL SITE	60	-
AQUILA, INC. - PUEBLO POWER PLANT	39	-
BLACK HILLS ELECTRIC- W.N. CLARK STATION	255,426	-
COLORADO ENERGY NATIONS COMPANY LLLP (GOLDEN FACILITY)	559,977	-
LAMAR	48	-
PLAINS END GENERATING STATION	47,909	-
PUBLIC SERVICE CO DENVER STEAM PLT	59,601	-
THERMO POWER & ELECTRIC LLC	68,637	-
UNIVERSITY OF COLORADO BOULDER - UTILITY SERVICES	38,945	-
Subtotal of Smaller Units	1,030,642	-
Total Emissions CO_2e	**40,511,607**	**39,215,180**
Total Emissions - excuding Smaller Units $MMTCO_2e$	**39.5**	**39.2**

* Only facilities of 25 MW report to CAMD

Examples of Data Used – Coal

- 1990-2010
  - Underground ventilation of CH4 (less recovery) +
  - Tons of mined surface coal x basin specific EF for CH4 (SW Rockies) factor +
  - Post-handling underground and surface based on tons produced
  - Multiplied by 21 to convert to CO_2e
- Projections
  - % of Colorado emissions determined (9.6% based on 2003 data)
  - 9.6% multiplied by EIA



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Stakeholder Concerns

- Purpose of the Inventory
- Emission Factors
- Electrical Power
- Oil and Gas
- Others

Recommendations for Next Steps

- Recommendation
  - working group composed of stakeholders examine the opportunities for improving our understanding of emissions from
    - Electrical Power – projections
    - Electrical Power – consumption
    - Oil and Gas

Questions

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