

NDCEE

National Defense Center for Energy and Environment

Developing a Greenhouse Gas Footprint for an Army Installation

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19 June 2008

The NDCEE is operated by:  *Concurrent Technologies Corporation*



DoD Executive Agent

Office of the
Assistant Secretary
of the Army
(Installations and
Environment)

Project Origins Demonstration/Validation Project for EMIS/EMS

- FY05, FY06, FY08 appropriations to prove EMIS/EMS applicability
- Developed compliance and process solutions for selected installations
- Through the National Defense Center for Energy and Environment (NDCEE) worked with FORSCOM, TRADOC, AMC, MEDCOM, NGB, USAR
 - Forts Carson, Benning, Detrick; Anniston Army Depot, WV, CA, HI Army Guard, 9th RRC
- Developed solutions in most disciplines at installations
 - Air emissions, Title V permit management, water – DMR, HW management, and reporting, EMS ISO14001, inspections and audits, asbestos, regulatory reporting, GHG footprint
- Resulted in proven Value-Added benefits
 - Reduced risk of fines, NOV's
 - Single repository source and reporting tool
 - Institutionalized data
 - Cost avoidance and efficiency

GHG Footprint Objectives - DASA-ESOH

- Standard approach to GHG inventories
- Scalable solution which can be applied at other installations
- Consistent reporting and rollup
- Demonstrate capability to comply with EO 13423
 - Strengthening Federal Environmental, Energy, and Transportation Management
 - Sec. 2. Goals for Agencies. In implementing the policy set forth in section 1 of this order, the head of each agency shall:
 - (a) improve energy efficiency and reduce greenhouse gas emissions...

GHG Footprint Objectives Ft. Carson DPW

- Build on existing emissions inventory
- Demonstrate initiative with regard to Colorado Department of Public Health and Environment (CDPHE)
- Contribute to Ft. Carson sustainability efforts

GHG Footprint Major Project Components

- Detailed Project Plan
 - Identified approach, sources, and detailed emission estimating procedures (Dec 07)
- Configuration into existing Ft. Carson EMIS (Mar 08)
- Training (Mar 08)
- Adoption (ongoing)

Department of the Army



Greenhouse Gas Management System

GHG Emissions Inventory
Ft. Carson, CO

Ft. Carson GHG Footprint

- **Scope 1 Emissions** – Direct GHG emissions from sources within the boundary of Ft. Carson: stationary, mobile, fugitive
- **Scope 2 Emissions** - Indirect GHG emissions from purchased electricity, heat, or steam consumed at the Installation, but not generated by sources within the boundary of Ft. Carson
- **Scope 3 Emissions** - Other indirect GHG emissions which are a consequence of Installation activities but are emitted from sources not owned or controlled by Ft. Carson
- **GHG Reduction Projects** – permanent removal or offset of GHG emissions resulting from planned human activity

Scope 1- Direct Emissions

Direct Emissions: on-installation sources

- Stationary External Combustion Sources (boilers, heaters, etc.)
- Internal Combustion Sources (generators, dynamometers, airfield engine testing)
- Military Training – Munitions Expended
- On-Installation Landfills
- Fire Training
- Prescribed Burning (Grassland Management)
- GSA/DPW Fleet Vehicles
- Tactical Vehicles (land & air)
- Tactical Vehicles Maintenance (fugitive emissions)

Scope 2 & 3: Indirect and Other Emissions

- **Scope 2: Indirect GHG emissions**
(from purchased electricity, heat, or steam)
 - Purchased power—Colorado Springs Utility
 - Renewable energy
- **Scope 3: Other indirect emissions**
 - Construction Vehicles (tenants and contractors)
 - Commercial Delivery Vehicles (includes all commercial traffic)
 - Waste Disposal – Landfill Emissions (tons of Solid Waste disposed off site)
 - Employee Travel – VMT for privately owned vehicles, based on registered vehicle counts.

Calculating GHG Emissions

- **Six GHG Gases:** Carbon Dioxide (CO₂), Methane (CH₄), Nitrous Oxide (N₂O), Hydrofluorocarbons (HFC's), Perfluorocarbons (PFC's), and Sulfur Hexafluoride (SF₆).
- **Calculate Emissions** for each GHG using established protocol methods and emission factors, examples include:
 - US EPA Emissions Estimates (AP 42)
 - U.S. EPA, *Inventory of Greenhouse Gas Emissions and Sinks: 1990-2005* (2007)
 - IPCC Guidelines for National Greenhouse Gas Inventories
- **Convert Emissions** for each GHG using established Global Warming Potentials (GWP)
- **Report results** in Carbon Dioxide Equivalents in metric tons (CO₂e) for each source and aggregate across Installation

Ft. Carson – A GHG Prototype

- Uniform Definitions
- Standard Libraries
- Standardized Calculations
- Standard Templates
- Standard Models
- Standard Data Rollups and Reporting

Uniform Definitions

- Organizational and geographic boundaries at installations
- All six GHG gases and global warming potentials
- Standard equipment and GHG source categories for Army assets and programs
- GHG Intensity Metrics
- Verification protocols (modeled after CCAR and TCR)
- Critical terms, such as:
 - **CO₂ Sinks:** Locations in the environment that permanently absorb and store significant amount of CO₂
 - **GHG Emissions Credit:** A permanent, enforceable, quantifiable and surplus GHG emissions reduction certified by a qualified party and which may be used for the purpose of offsetting emissions

Standard Libraries

- Standardized and Universally Applied
 - Emission Factors
 - Conversion Factors
 - Global Warming Potentials
 - Historized Values

The screenshot shows a software interface with a tree view on the left and a table on the right. The tree view is titled 'System Models' and shows a hierarchy starting with 'US Army - Fort Carson (Home)'. Underneath, there are folders for 'Locations & Programs [21]', 'GHG Management System [5]', and 'Air Project Reviews [7]'. The 'GHG Management System' folder is expanded, showing sub-items like '.Direct Emissions (Scope 1) [4]', '.Indirect Emissions (Scope 2) [4]', and 'GHG Conversion Factors [7]'. The 'GHG Conversion Factors' folder is further expanded, showing 'CO2e GWP Conversion Factors', 'Conversion Factors_Other [7]', 'Indirect Emissions [3]', 'Mobile Emissions [12]', and 'Stationary [7]'. The table on the right is titled 'Search' and shows a list of conversion factors. The table has two columns: 'Select' and 'Name'. The 'Name' column lists various greenhouse gases and their conversion factors to CO2E, such as C2F6 to CO2E, C3F8 to CO2E, C4F10 to CO2E, C5F12 to CO2E, C6F14 to CO2E, CF4 to CO2E, CH4 to CO2E, HFC-125 to CO2E, HFC-134a to CO2E, HFC-143a to CO2E, HFC-152a to CO2E, HFC-227ea to CO2E, HFC-23 to CO2E, HFC-236fa to CO2E, HFC-43-10mee to CO2E, N2O to CO2E, and SF6 to CO2E. The table also shows 'Page: 1 of 1' and a search bar.

Select	Name ▲
<input type="checkbox"/>	# C2F6 to CO2E
<input type="checkbox"/>	# C3F8 to CO2E
<input type="checkbox"/>	# C4F10 to CO2E
<input type="checkbox"/>	# C5F12 to CO2E
<input type="checkbox"/>	# C6F14 to CO2E
<input type="checkbox"/>	# CF4 to CO2E
<input type="checkbox"/>	# CH4 to CO2E
<input type="checkbox"/>	# HFC-125 to CO2E
<input type="checkbox"/>	# HFC-134a to CO2E
<input type="checkbox"/>	# HFC-143a to CO2E
<input type="checkbox"/>	# HFC-152a to CO2E
<input type="checkbox"/>	# HFC-227ea to CO2E
<input type="checkbox"/>	# HFC-23 to CO2E
<input type="checkbox"/>	# HFC-236fa to CO2E
<input type="checkbox"/>	# HFC-43-10mee to CO2E
<input type="checkbox"/>	# N2O to CO2E
<input type="checkbox"/>	# SF6 to CO2E

Standard Calculations

- Consistent Formulae
- Unit of Measure Conversions for Easy Data Entry
- Consistent Output

Design your calculation:

```

IF (ISNULL([Usage Fuel Oil 2])) THEN
  (([Usage Natural Gas]*[CO2 EF_Natural Gas]*[Udf_UOM_NatGas]/1000)
ELSE
  IF (ISNULL([Usage Natural Gas])) THEN
  (([Usage Fuel Oil 2]*[CO2 EF_Distillate Fuel]*[Udf_UOM_Liquid]/1000)
ELSE
  ([Usage Natural Gas]*[CO2 EF_Natural Gas]*[Udf_UOM_NatGas]/1000)+([Usage Fuel Oil 2
  
```

7	8	9	/	10 ³	10 ⁶	10 ⁹	10 ⁻³	10 ⁻⁶	10 ⁻⁹
4	5	6	*	sin	cos	tan	asin	acos	atan
1	2	3	-	sinh	cosh	tanh	sign	abs	pi
0	.	,	+	exp	sqrt	ln	log ₁₀	e	
()	=	^	Round	Floor	Ceiling	Antilog	Rem	
<	>	!=	and	or	not	If-then	last	prev	self
days in month		days in quarter		days in half-year		days in year			
IsNull		null							
Sum All									

Available parameters:

CO2 EF_Distillate Fuel	CO2 EF_Natural Gas	Usage Fuel Oil 2	Usage
UOM_NatGas	UOM_Liquid		

Standard Templates

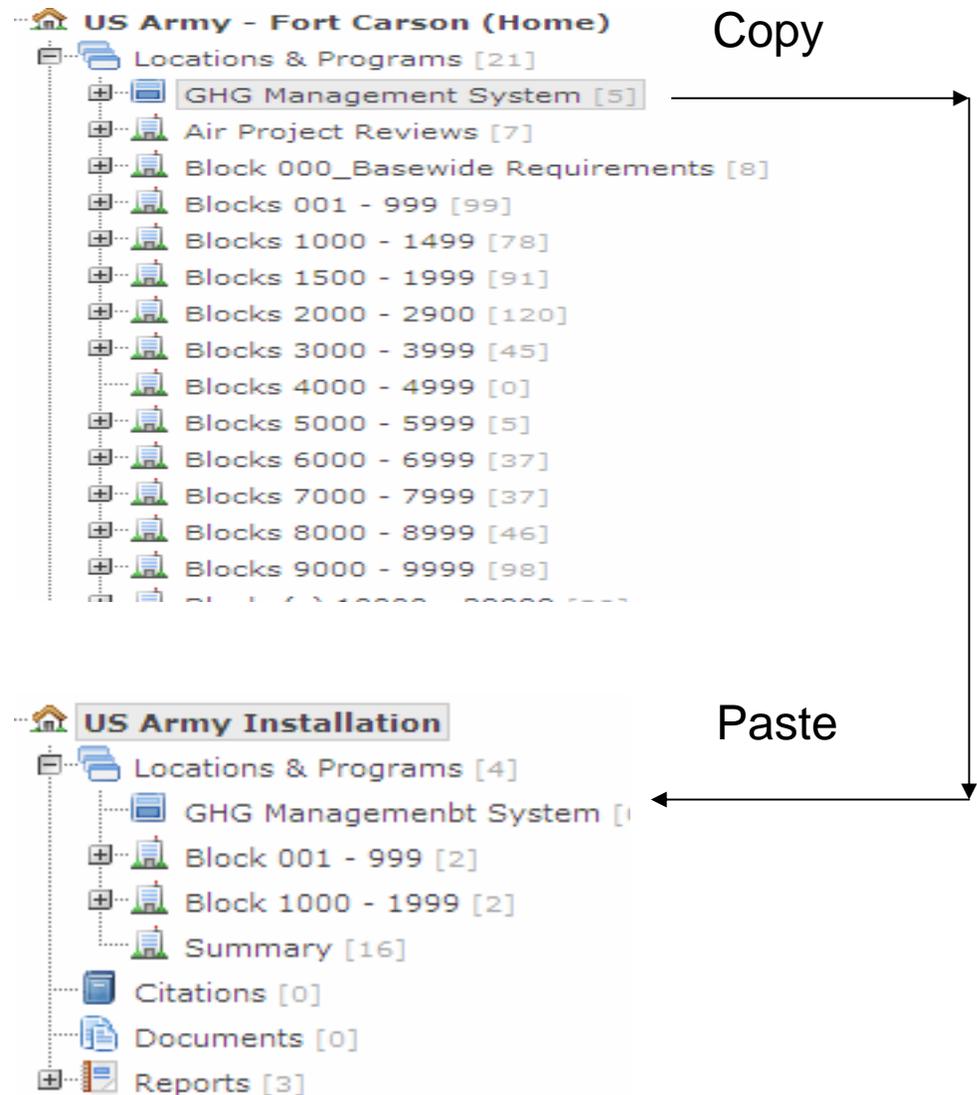
- Uniform Source Categories
- Utilize Standard Calculations
- Uniform Template Library for all Installations
- Copy and Paste by Installation Personnel

The screenshot displays the Enviance software interface. At the top, there are navigation tabs: Desktop, Calendar, Messages, Tasks, Custom Field Library, Templates, and Mater. Below these is a 'System Models' window showing a tree view for 'US Army - Fort Carson (Home)'. The tree includes categories like 'Locations & Programs [21]', 'GHG Management System [5]', and various emission sources such as 'Direct Emissions (Scope 1) [4]' and 'Indirect Emissions (Scope 2) [4]'. The 'Mobile Sources [121]' category is highlighted. To the right, the 'Applicable Requirements' panel shows a search bar and a table of requirements.

Select	Name ▲
<input type="checkbox"/>	Heavy Duty Vehicle 1990-pres Gasoline [4]
<input type="checkbox"/>	Heavy Duty Vehicle 1996 to pres Diesel [4]
<input type="checkbox"/>	Heavy Duty Vehicle All Model Years LNG [3]
<input type="checkbox"/>	Jet Fuel [1]
<input type="checkbox"/>	Light Duty Truck 2000-pres CNG [3]
<input type="checkbox"/>	Light Duty Truck 2000-pres E85 [3]
<input type="checkbox"/>	Light Duty Truck 2000-pres Gasoline [4]
<input type="checkbox"/>	Light Duty Truck All Model Years Diesel [4]
<input type="checkbox"/>	Passenger Cars 2000-present CNG [3]
<input type="checkbox"/>	Passenger Cars 2000-present Diesel [4]

Standard Installation Model

- Entire Ft. Carson GHG Model is Easily Reproduced at any Installation
- Automatically Incorporates Standard Definitions, Calculations, Templates
- Simple Customization
 - Copy and Paste Templates
 - Rename to Match Local Equipment



Direct Emissions - Stationary Sources

- Stationary External Combustion Sources (boilers, heaters)
 - Fuel type – Natural Gas, #2 Fuel Oil, Diesel, Propane
 - GHG's emitted – CO₂, CH₄, N₂O
 - Emissions estimating method
 - CO₂ from U.S. EPA, *Inventory of Greenhouse Gas Emissions and Sinks: 1990-2005* (2007), Annex 2.1
 - CH₄ & N₂O from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Chapter 2: Stationary Combustion
 - Input data – standard cubic feet (gas/propane), gallons (oil/diesel)
 - Additional info – Usage data already in Enviance for Title V air emissions inventory (metered gas fuel use corrected for altitude)
 - Confidence level – High, certified Title V sources

Standard Template Combustion Source as Implemented at Ft. Carson

- Standard Template for External Combustion used to create actual sources at Ft. Carson
- Each of these actual sources utilize the standard calculations
- Next slide shows leveraging existing Title V data to produce the GHG emissions for these sources

The screenshot displays the 'System Models' interface. On the left, a tree view shows the hierarchy: US Army - Fort Carson (Home) > Locations & Programs [21] > GHG Management System [5] > Direct Emissions (Scope 1) [4] > Stationary Combustion Units [6]. Under Stationary Combustion Units, 'Boiler 1860D [8]' is highlighted. Other units listed include 'Boiler-Hot Water Generator (Dual Fuel NG c...', 'CE Boiler Group -- Low NOx (Natural Gas) [...]', 'CE Boiler Group -- Misc ECU (Natural Gas) [...]', 'CE Boiler Group -- Misc ECU (Propane) [8]', and 'CE Boiler Group -- Standard Burner (Natura...'. Below this are 'Indirect Emissions (Scope 2) [4]', 'Other Indirect Emissions (Scope 3) [4]', and 'GHG Conversion Factors [7]'. On the right, the 'Applicable Requirements' panel shows the path 'US Army - Fort Carson > GHG Management' and a search bar. Below the search bar, it indicates 'Page: 1 of 1' and '1'. A table lists requirements with checkboxes and names:

Select	Name ▲
<input type="checkbox"/>	CH4
<input type="checkbox"/>	CO2
<input type="checkbox"/>	CO2E
<input type="checkbox"/>	CO2E Annual
<input type="checkbox"/>	N2O
<input type="checkbox"/>	Usage Fuel Oil 2
<input type="checkbox"/>	Usage Natural Gas
<input type="checkbox"/>	Verification

Applicable Requirements
US Army - Fort Carson > Blocks 1500 - 1999 > Bldg_1860

Name: b1
Tag:
Type: Parameter Requirement
 Include all children
 Display full object path

Requirement Template: -- select --
Custom Field Template: -- select --
 Selection Criteria

Page: 1 of 1 1

Select	Name ▲
<input type="checkbox"/>	#2 Oil Monthly Fuel Use (Gal) B1
<input type="checkbox"/>	# Total Natural Gas Use B1 & B2 (Cubic feet)

Page: 1 of 1 1

Example: Boiler,
Bldg 1860

Fuel Use Entered for
Existing Title V Emission
Inventory

Applicable Requirements
US Army - Fort Carson > GHG Man
Units > Boiler 1860D

Page: 1 of 1 1

Select	Name ▲
<input type="checkbox"/>	CH4
<input type="checkbox"/>	CO2
<input type="checkbox"/>	CO2E
<input type="checkbox"/>	CO2E Annual
<input type="checkbox"/>	N2O

Automatically Triggers
GHG Emissions
Calculations in the GHG
Model. (No separate data
entry required.)

Direct Emissions - Installation Vehicles

- Installation Vehicles (not tenants and contractors)
 - Fuel type – Diesel, Gasoline
 - GHG's emitted – CO₂, CH₄, N₂O
 - Emissions estimating method – U.S. EPA, *Inventory of Greenhouse Gas Emissions and Sinks: 1990-2005 (2007)* – highway vehicle tables
 - Input data – Vehicle Miles Traveled, Fuel usage, # Vehicles
 - Confidence level – High, input data for standard methods is available

Standard Template Mobile Sources at Ft. Carson

- Standard Template for Mobile Source used to match actual vehicle classes at Ft. Carson
- Each of these actual sources utilize the standard calculations
- Next slide shows use of standard emission factors and Ft. Carson VMT data to produce the GHG emissions for these sources

The screenshot displays the Enviance software interface. The left pane shows a tree view of 'System Models' for 'US Army - Fort Carson (Home)'. The 'Mobile Sources' folder is selected, showing 12 items. The right pane, titled 'Applicable Requirements', shows a list of vehicle categories with checkboxes for selection.

Select	Name
<input type="checkbox"/>	Heavy Duty Vehicle 1990-pres Gasoline [4]
<input type="checkbox"/>	Heavy Duty Vehicle 1996 to pres Diesel [4]
<input type="checkbox"/>	Heavy Duty Vehicle All Model Years LNG [3]
<input type="checkbox"/>	Jet Fuel [1]
<input type="checkbox"/>	Light Duty Truck 2000-pres CNG [3]
<input type="checkbox"/>	Light Duty Truck 2000-pres E85 [3]
<input type="checkbox"/>	Light Duty Truck 2000-pres Gasoline [4]
<input type="checkbox"/>	Light Duty Truck All Model Years Diesel [4]
<input type="checkbox"/>	Passenger Cars 2000-present CNG [3]
<input type="checkbox"/>	Passenger Cars 2000-present Diesel [4]

Models

- GHG Conversion Factors [7]
- CO2e GWP Conversion Factors [17]
- Conversion Factors_Other [7]
- Indirect Emissions [9]
- Mobile Emissions [12]
 - Heavy Duty Vehicle_1990-pres_Gasoline [4]
 - Heavy Duty Vehicle_1996 to pres_Diesel [4]
 - Heavy Duty Vehicle_All Model Years_LNG [3]
 - Jet Fuel [1]
 - Light Duty Truck_2000-pres_CNG [3]
 - Light Duty Truck_2000-pres_E85 [3]
 - Light Duty Truck_2000-pres_Gasoline [4]
 - Light Duty Truck_All Model Years_Diesel [4]
 - Passenger Cars_2000-present_CNG [3]
 - Passenger Cars_2000-present_Diesel [4]
 - Passenger Cars_2000-present_E85 [4]
 - Passenger Cars_2000-present_Gasoline [3]

Applicable Requirements

US Army - Fort Carson > GHG Management

Search

Page: 1 of 1 1

Select	Name ▲
<input type="checkbox"/>	#_CH4 EF_Gasoline
<input type="checkbox"/>	#_CO2 EF_Gasoline
<input type="checkbox"/>	#_N2O EF_Gasoline

Page: 1 of 1 1

Example: Passenger Cars
(Gasoline)

Emission Factors (emission per
mile traveled) from Standard
Library...

Multiplied by...

Ft. Carson Vehicle Miles Traveled
Data (uploaded via Excel)

GHG Emissions
(Standard Components
and Units of Measure)

System Models

- US Army - Fort Carson (Home)
 - Locations & Programs [21]
 - GHG Management System [5]
 - Direct Emissions (Scope 1) [4]
 - Fugitive Sources [0]
 - Mobile Sources [12]
 - Heavy Duty Vehicle_1990-pres_Gasoline [4]
 - Heavy Duty Vehicle_1996 to pres_Diesel [4]
 - Heavy Duty Vehicle_All Model Years_LNG [3]
 - Jet Fuel [1]
 - Light Duty Truck_2000-pres_CNG [3]
 - Light Duty Truck_2000-pres_E85 [3]
 - Light Duty Truck_2000-pres_Gasoline [4]
 - Light Duty Truck_All Model Years_Diesel [4]
 - Passenger Cars_2000-present_CNG [3]
 - Passenger Cars_2000-present_Diesel [4]
 - Passenger Cars_2000-present_E85 [3]
 - Passenger Cars_2000-present_Gasoline [6]

Applicable Requirements

US Army - Fort Carson > GHG Management

Search

Page: 1 of 1 1

Select	Name ▲
<input type="checkbox"/>	#_Vehicle Miles Traveled
<input type="checkbox"/>	#_CH4
<input type="checkbox"/>	#_CO2
<input type="checkbox"/>	#_CO2e
<input type="checkbox"/>	#_CO2e Annual
<input type="checkbox"/>	#_N2O

Page: 1 of 1 1

Indirect Emissions - Purchased Electricity

- Colorado Springs Utilities
- GHG's emitted – CO₂, CH₄, N₂O
- Input data – MWh metered, emission factors for CO₂, N₂O, and CH₄
- Emission Factor Sources
 - CO₂ – Colorado Springs Utilities
 - N₂O and CH₄ - US Department of Energy, Revised/Updated State-Level GHG EF's for Electricity (February 2000)
- Emissions estimating method – MWh metered multiplied by individual emission factors for CO₂, N₂O, and CH₄. GWP's applied to yield CO₂e.
- Confidence level – High, metered values for MWh and standard emission factors

GHG Emission - Reduction Projects

- Several energy efficiency and renewable energy projects are being considered that may result in GHG emission reductions:

Source	Comments
Solar water heaters	GHG savings from reduced electric/gas utility purchases.
Transpired solar collectors	GHG savings from reduced electric utility purchases.
Johnson Controls EE RFP	GHG savings from reduced electric/gas utility purchases.
HVAC control system	GHG savings from reduced electric/gas utility purchases.
Biomass Sequestration	GHG offsets through managed projects.
REC trading	GHG credits associated with renewable energy credit purchases.

GHG Footprint and Management Reports

The System will generate the following Installation-level reports:

Directorate of Public Works (DPW)

- *Federal Report* – DOE/EIA 1605b Voluntary GHG Reporting Program
- *Intensity-based Metrics* – US Army metrics to be established

Fort Carson Command

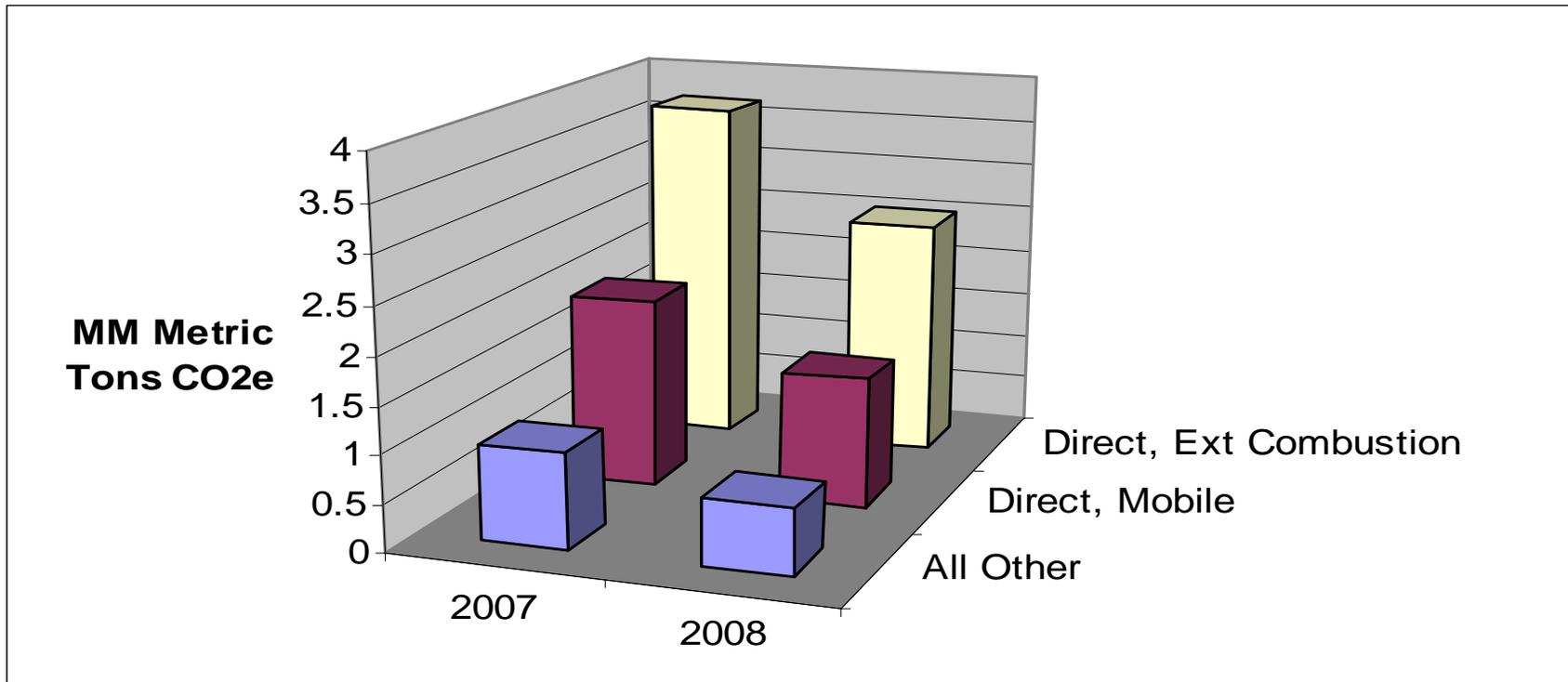
- *Greenhouse Gas Emission Annual Inventory Report* – addendum to current AEI report for Criteria Pollutants (PM10, NOx, CO, VOC, SO₂, Pb) and Hazardous Air Pollutants
- *Sustainability Report* – GHG performance measures to be included in annual sustainability report

State Voluntary Reporting

- *The Climate Registry* -- Voluntary multi-state registry adopted by 39 states (including Colorado) as best management practice for state-level reporting (format not yet determined)

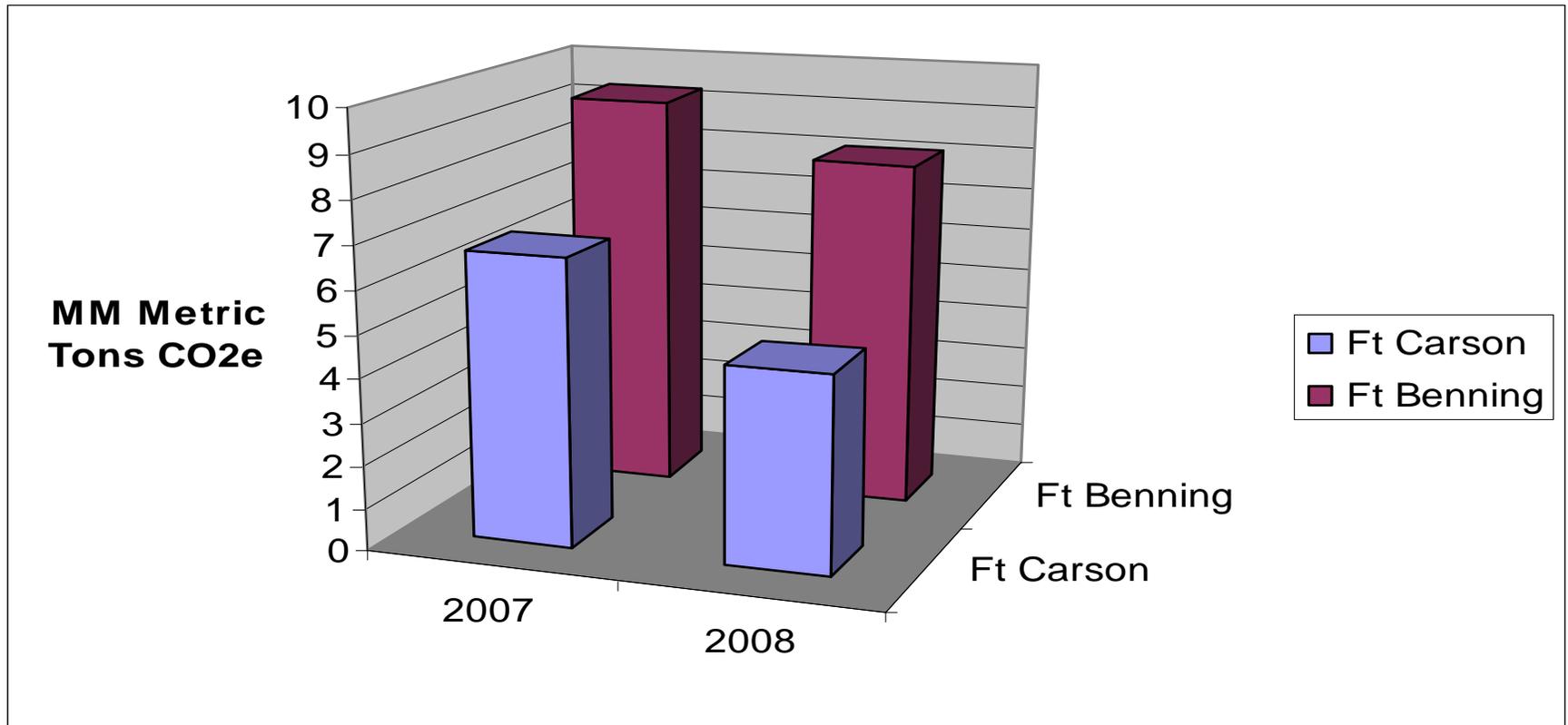
Rollup Reports

Compare Sources at Ft. Carson



Rollup Reports

Compare Entire Installations



Contact Information

Task N. 490 – Development of a Greenhouse Gas (GHG) Footprint Creating and Assessment Methodology for the U.S. Army

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Questions and Answers

