

Verifier Accreditation Training for Mandatory Greenhouse Gas Reporting

General Verification
Course 1.4 - Electricity Generating Units
and Cogeneration

California Environmental Protection Agency

 **Air Resources Board**



Verifier Accreditation Training for Mandatory Greenhouse Gas Reporting

Course 1: General Verification

1.1 Verification Context, Principles, and Program
Overview

1.2 Stationary Fuel Combustion and Sorbent
Sources

1.3 Accuracy and Product Data

1.4 Electricity Generating Units and Cogeneration

Course 1.4 Handouts

- 1.4.1 Energy Disposition
- 1.4.2 Sample Cogeneration Emissions Data Report
- 1.4.3 Comprehensive Case Study

Course 1.4 Electricity Generating Units and Cogeneration

1. Applicability
2. Comparison of MRR § 95112 and 40 CFR Part 98
3. Electricity Generating Units
4. Verifying Emissions Data
5. Group Participation Exercises

MRR § 95112 - Applicability

Facilities subject to MRR with Electricity Generating Units (EGUs)

- Must follow § 95112 for EGUs if ≥ 1 MW
- When total nameplate generating capacity < 1 MW, must report, but may elect to follow § 95115 and report EGUs as stationary fuel combustion
- Other (non-EGU) SFC sources report under § 95115



Facility Types Reporting under § 95112

- EGUs that are subject to the requirements of the Acid Rain Program and 40 CFR Part 75
- Geothermal electricity generating facilities
- EGUs include cogeneration and bi-generation units, as well as facilities that generate only electricity and no steam
- Exclusion
 - Electricity generating facilities that are solely powered by nuclear, hydroelectric, wind, or solar power **with stationary fuel combustion emissions < 10,000 MT CO₂e**

§ 95112 and Subparts C and D

§ 95112 consistent with 40 CFR Part 98 except

- Refers to Subparts C and D as modified by § 95115
- Requires reporting of
 - CO₂, CH₄, and N₂O emissions reported by fuel type for each EGU (or aggregated group of EGUs) subject to reporting
 - Information about the electricity generating facility and units (§95112(a) and (b))
 - CO₂ and CH₄ emissions from geothermal facilities (§95112(e))
 - CO₂ emissions from hydrogen fuel cells (§95112(f))
 - On-site renewable electricity generation (§95112(g))

Energy Data Reported Under § 95112

- Disposition of generated electricity and thermal energy (§95112(a)(4-5))
- Block diagram of equipment, energy flows, and meter locations (§95112(a)(6))
- For cogeneration or bigeneration units, total thermal output generated by the unit that can be potentially utilized in other industrial operations that are not electricity generation ((§95112(b)(3))
- Detailed reporting of steam or heat acquired from external sources for power generation (§95112(b)(8))
- For bottoming cycle cogeneration units only, also report input steam to the steam turbine and the output of the heat recovery steam generator (§95112(b)(8))

Methods to Calculate CO₂ Emissions

Facilities/Units Subject to Part 75 are given a choice to report either

– Under Part 75 (Subpart D)

- Fuel-based methodology (40 CFR 75.13(b) and Appendix G, Section 2.3, Eq. G-4), or
- CO₂ or O₂ monitors (40 CFR 75.13(a)-(c))

or

– Under Part 98 (Subpart C)

- Applicable Part 98 (Tier) methods may be used (§ 95112(c))
 - subject to the limitations in §95103(m) for changing methods after 2013

Geothermal Facilities/Units: Methods to Calculate CO₂ and CH₄ Emissions

Source-specific emission factors derived from an ARB approved measurement plan (§ 95112(e))



Questions and ARB Comments

1. Applicability
2. Comparison of MRR § 95112 and 40 CFR Part 98
- 3. Electricity Generating Units**
 - Boundaries
 - Types
 - System Energy Accounting
4. Verifying Emissions Data
5. Group Participation Exercises

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Data Reported by Facility/EGU

- Unit ID number (CEC, EPA, etc.)
- Nameplate generating capacity by unit
- Type of facility
- Disposition of generated electricity
 - Provided to retail provider or marketer who distributes over the grid (name of provider/marketer)
 - Provided or sold directly to particular end-users (customers)
 - If applicable, amount of electricity used by industrial processes/operations on site

Electricity Generating Facilities/Units Subject to Verification

- Approximately 270 facilities were verified that generated electricity
 - 113 stand-alone power plants
 - 84 industrial/institutional/commercial facilities
 - Oil and gas, universities, paper manufacturing, landfills, etc.
 - 69 independently operated cogeneration facilities
 - 4 bigeneration plants
- Fuel is mostly natural gas, with some biomass-derived fuel, refinery fuel gas, and several geothermal plants

Facility Boundary § 95112(a)(3)

- Stand-alone - Independently operated and sited facility
 - Only emissions within facility boundary are reported
- Industrial/institutional/commercial electricity generating facility
 - Emissions from adjacent or co-located thermal host included in the facility boundary if shared ownership or operational control
 - Emissions from non-adjacent thermal host not included

Types of Cogeneration Facilities/Units

- Approximately 140 electricity-only power plants (not cogeneration, but includes combined cycle)
- 125 topping cycle cogeneration facilities
 - Oil and gas, hospitals and universities, food processing, lumber mills, refineries
- 5 bottoming cycle cogeneration facilities
 - Hydrogen production
 - Calciners

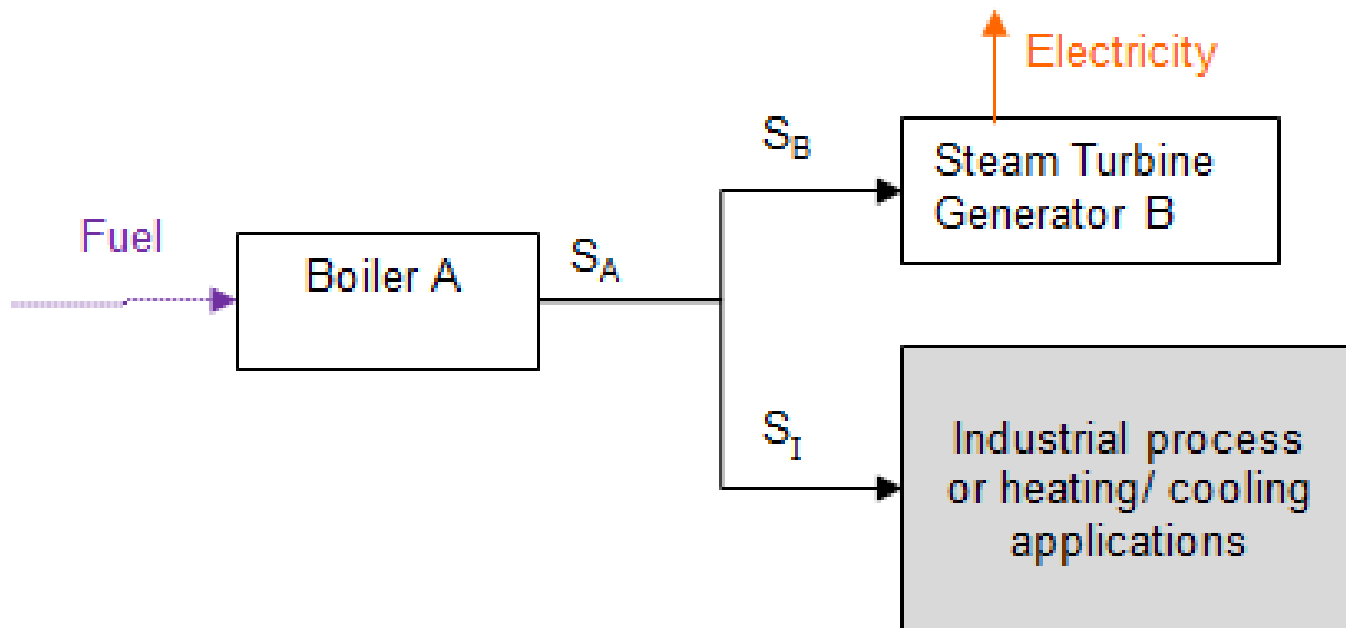
Thermal Energy Generation Data

Video of cogeneration

<http://www.youtube.com/watch?v=dRqqUCLjmqE>

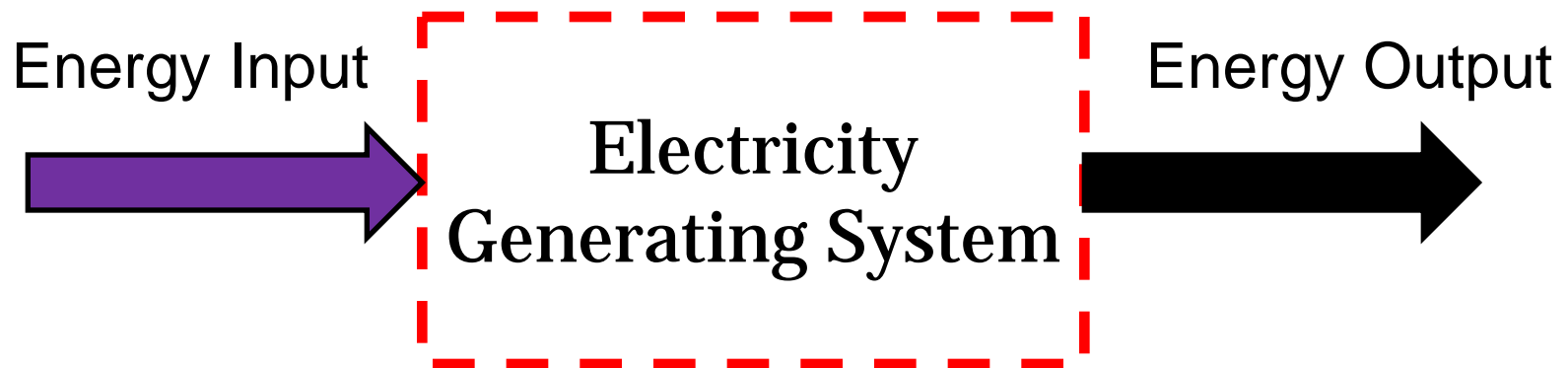
Bigeneration § 95112(a)(3) and (b)(1)(D)

EGU that simultaneously produces electricity and steam from the same fuel source but does not utilize waste heat



System Energy Accounting (1 of 2)

“System boundary” is the foundation for determining what energy quantities are to be reported under § 95112(a) and (b)



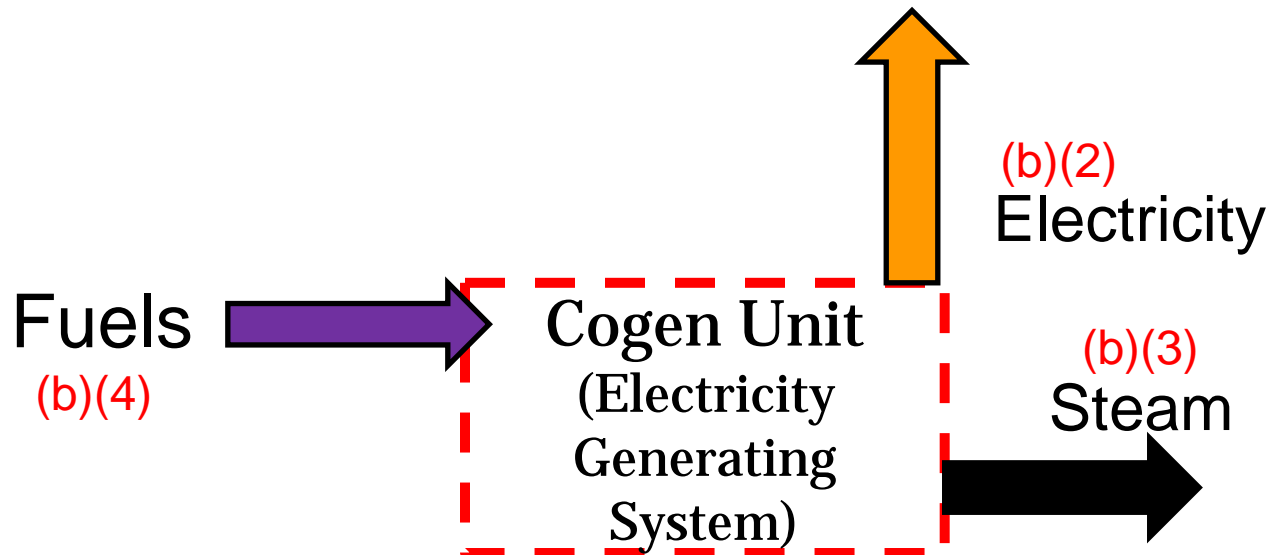
The difference between energy input and energy output is waste energy (e.g., vented steam and mechanical friction)

System Energy Accounting (2 of 2)

- § 95112(a) - Indicates where the generated energy flows go after they leave the system
- § 95112(b) - Accounts for the energy inputs and outputs of the EGU or the electricity generating system
- To ensure the system energy balance is completely accounted for, a system energy diagram is critical

Simplified Block Diagram § 95112(a)(6)

- Equipment associated with the electricity generating system, and any equipment or industrial processes outside of the system that may inform energy flows
- Flows of energy (fuel input, electricity output, thermal output) shown with arrows and labels



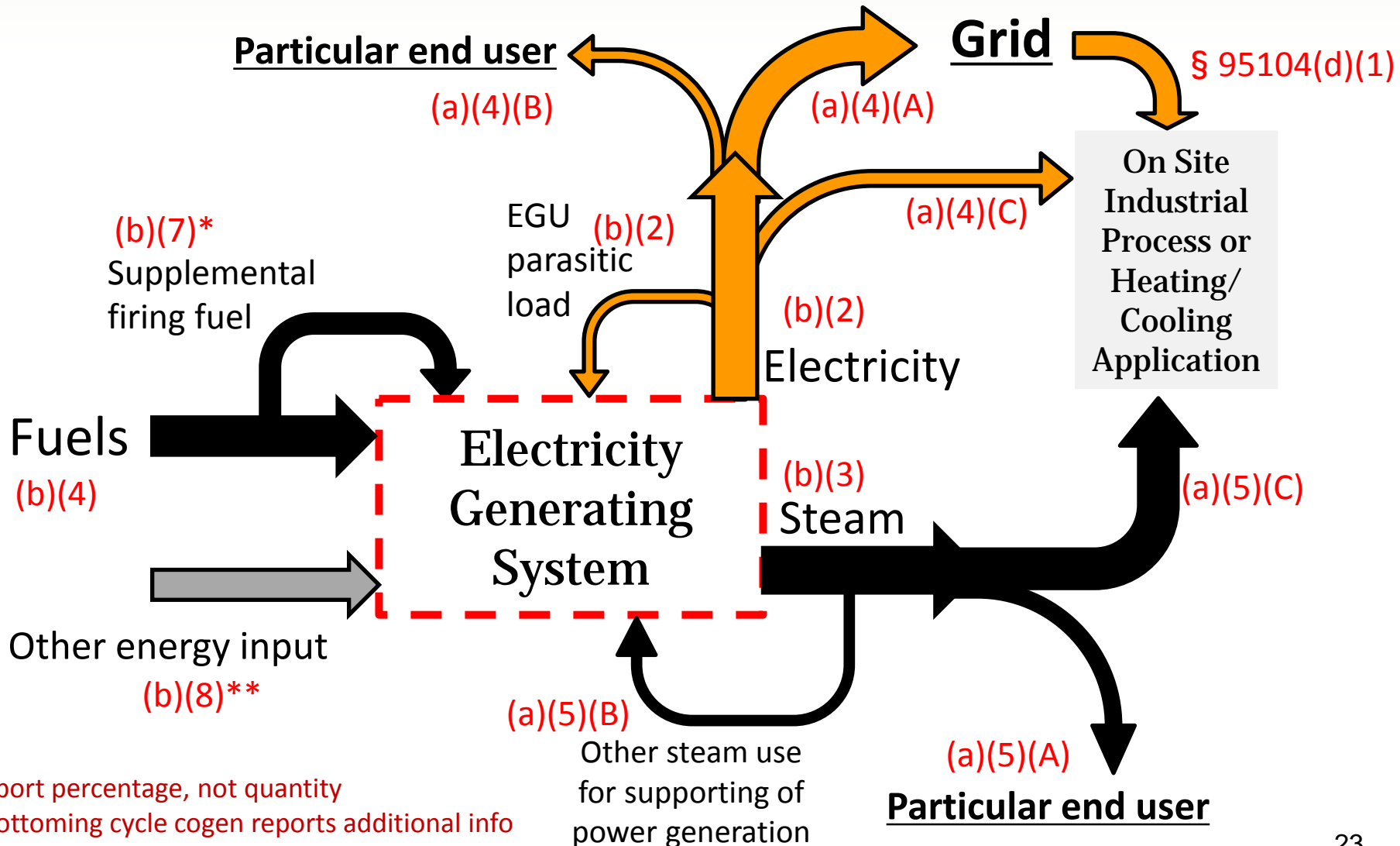
System Approach

- Reporters aggregate the individual units in an electricity generating system (EGS) if the units are integrated
- Types of systems
 - Cogeneration system
 - Bigeneration system
 - Combined-cycle electricity generation system
 - System of boilers producing steam to power steam turbine generators
- Auxiliary or stand-by boilers
 - If the boiler does not contribute to electricity generation (boiler steam feeds a steam turbine generator), report it separately under subpart C

Data Reported by Cogeneration or Bigeneration Unit

- Thermal energy provided or sold to another end-user
- If applicable, amount of thermal energy used by industrial processes/operations on site not used to generate additional electricity
- Thermal energy excludes steam that is used for power production (e.g., steam used to drive a steam turbine generator)

Cogeneration System Energy Accounting



Total Thermal Output (1 of 2)

- Total amount of usable thermal energy that can potentially be made available for use in industrial/commercial processes, heating/cooling applications, or delivered to other end users. It includes
 - *Steam sold* § 95112(a)(5)(A). Thermal energy provided or sold to a particular end-user
 - *Parasitic Steam Use* § 95112(a)(5)(B). Thermal energy used for supporting power generation that has been included in the § 95112(b)(3) quantity but is not accounted for in either § 95112(a)(5)(A) or (C)
 - *Steam for Industrial Use* § 95112(a)(5)(C). Thermal energy used in other on-site industrial processes or heating/cooling applications that are not electricity generation
 - Thermal energy that is vented, radiated, or otherwise wasted
- Does not include steam to make more electricity

Total Thermal Output (2 of 2)

$$\text{The Sum: } \left\{ \begin{array}{l} \S 95112(a)(5)(A) \\ \S 95112(a)(5)(B) \\ \S 95112(a)(5)(C) \end{array} \right. \leq \S 95112(b)(3)$$

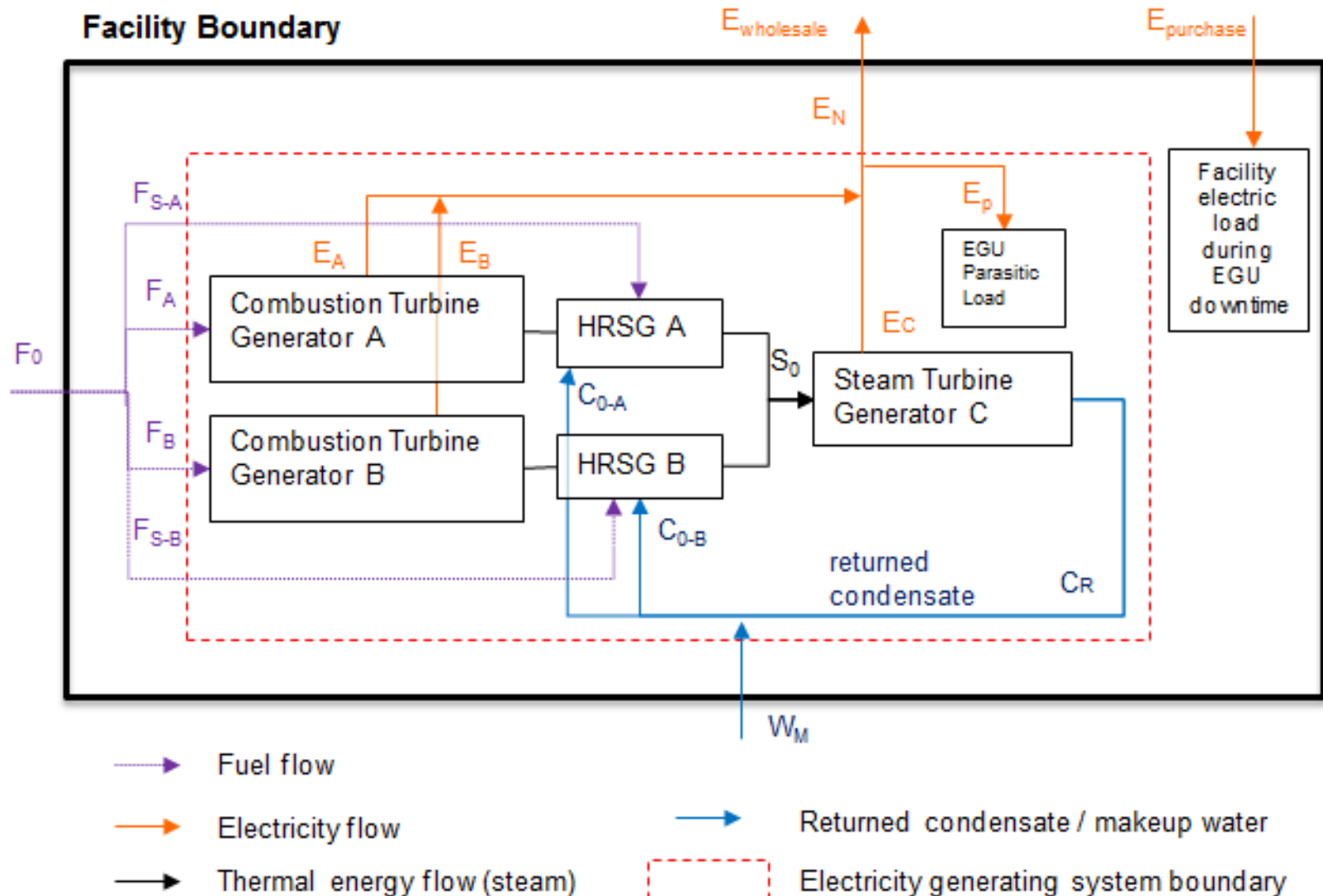
- The difference between the two sides of the comparison is the thermal energy that was generated by cogen/bigen units but was not utilized for any useful purpose (e.g., vented steam)
- Include only thermal energy generated by a cogen/bigen system in these quantities
- Engineering estimation is acceptable

Cooling Energy § 95112(a)(4)(C) and (a)(5)(C)

Cogeneration operator must now estimate and report electricity and thermal energy related to cooling energy (e.g., chilled water) if

- Provided to end user outside of facility boundary
or
- Used for an on-site industrial process that is not part of electricity generation

Example of Combined Cycle Electricity Generating Facility

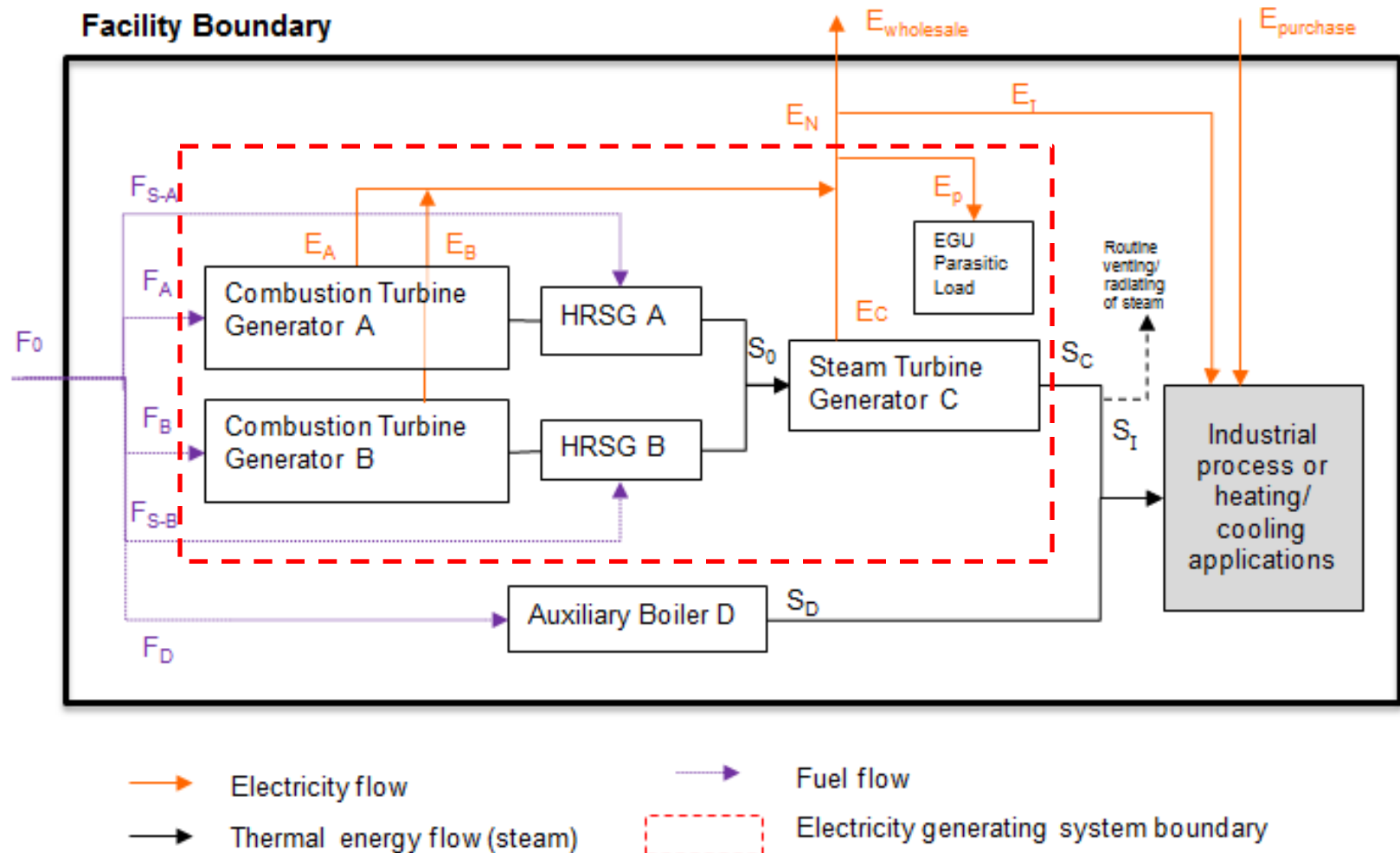


Electricity Generation Data

Gross vs. net generation (*Example for previous slide*)

§95112	Item Description	Quantity
(a)(4)(A)	Generated electricity provided to wholesale (grid)	$E_{\text{wholesale}}$
(a)(4)(B)	Generated electricity provided or sold directly to particular end-user	0
(a)(4)(C)	Generated electricity used by on-site industrial processes or operations that are neither in support of or a part of the power generation system	E_I
(a)(5)(A)	Generated thermal energy provided or sold to particular end-user	0
(a)(5)(B)	Generated thermal energy for supporting power production	0
(a)(5)(C)	Generated thermal energy used by on-site industrial processes or operations (exclude any wasted energy)	S_I
(b)(2)	Gross generation	$E_A + E_B + E_C$
(b)(2)	Net generation	$E_N = (E_A + E_B + E_C) - E_P$

Example of Topping Cycle Cogen and Separate Aux Boiler



Verifying Electricity Generation and Disposition

- Evidence to request
 - Electricity generation and disposition measurement records
 - In the absence of an electricity meter, other records used to develop an engineering estimate
 - Facility meter layout and uses
 - CEC 1304 forms (use as a cross-check; not as primary data)
- How to examine evidence
 - Examine electricity generation and disposition records for completeness and accuracy
 - Review and confirm reasonableness of any engineering estimates
 - Confirm what is reported as net and gross generation is consistent with the applicable definitions

Verifying Thermal Energy Production and Disposition

- Evidence to request
 - Thermal energy production and disposition measurement records
 - In the absence of a steam meter, other records used to develop an engineering estimate
- How to examine evidence
 - Examine thermal energy production and disposition records for completeness and reasonable accuracy
 - Review and confirm reasonableness of any engineering estimates

Verifiers are Required to Review Energy Generation and Disposition if... § 95131(b)(8)(F)

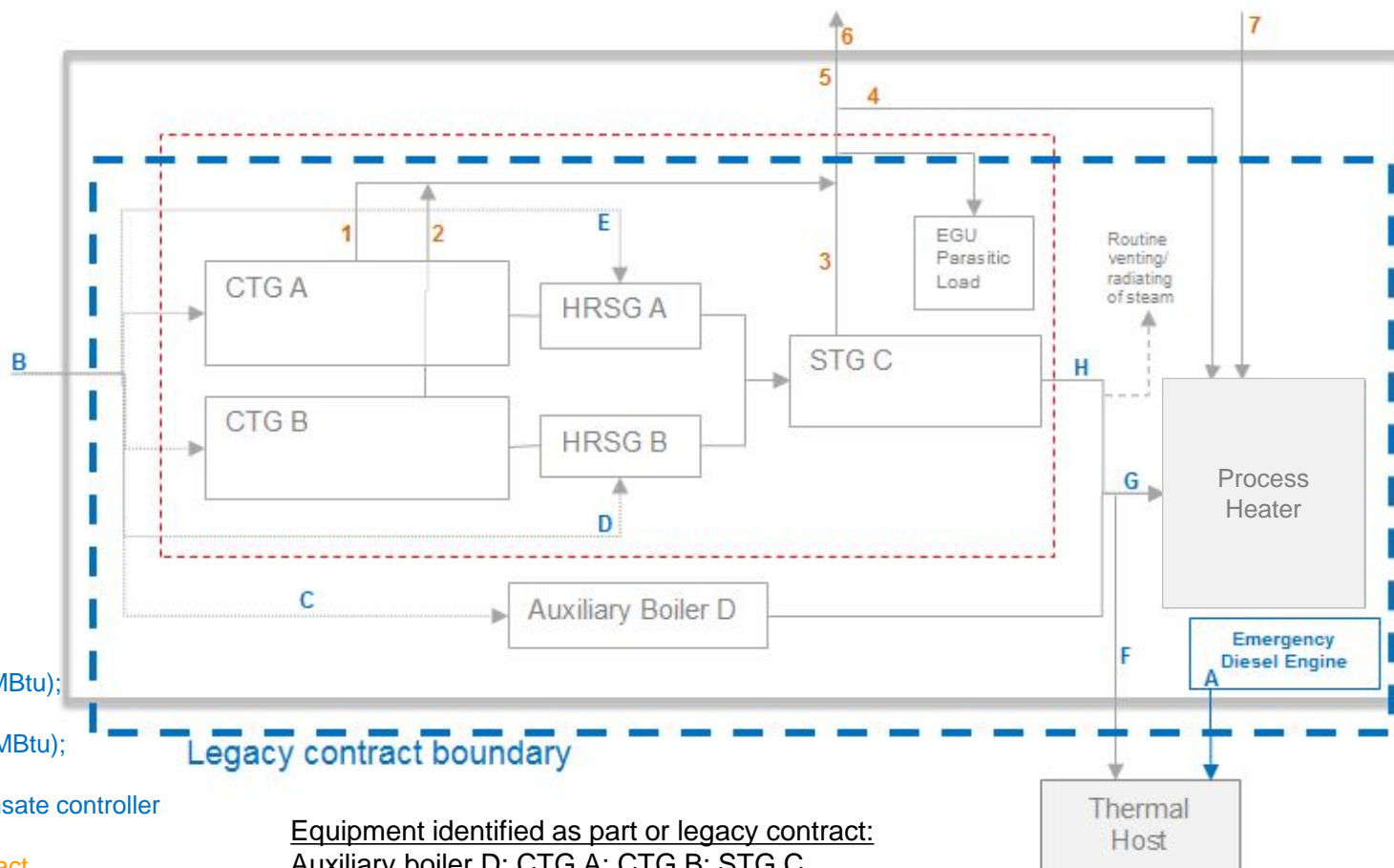
- The facility belongs to an industrial sector listed in Table 8-1 of the Cap-and-Trade Regulation;
- The operator is applying for legacy contract transition assistance¹ under the Cap-and-Trade Regulation; or
- The operator has applied for the limited exemption of emissions from the production of qualified thermal output pursuant to the Cap-and-Trade Regulation.²

¹ See new section 95112(i) for additional requirements for legacy contract data reporters; ARB will notify VB of legacy contract facility requirements upon COI submittal. A partial list of legacy contract generators is on page 13 of the Vintage 2015 Allowance Allocation report ([http://www.arb.ca.gov/cc/capandtrade/allowance allocation.v2015 allocation.pdf](http://www.arb.ca.gov/cc/capandtrade/allowance%20allocation.v2015%20allocation.pdf).)

² A complete list of entities is on page 14 of the Vintage 2015 Allowance Allocation report. 32

Legacy Contract Assistance Block Diagram

Not shown in this example but also required:
fuel consumed by CTG A and B, and emissions associated with each piece of equipment shown.



Blue = Part of legacy contract
A: Diesel engine fuel meter
(0 gallons used / 0 kw provided)
B: Utility revenue NG meter
SCG4553 (4,595,000 Therms)
C: NG fuel meter M104
(624,300 Therms)
D: Meter M110 (13,105 Therms)
E: Meter M111 (12,440 Therms)
F: Steam meter S33 (534,560 MMBtu);
120 psi saturated steam
G: Steam meter S32 (450,020 MMBtu);
80 psi steam
H: Steam conditioner and condensate controller

Equipment identified as part or legacy contract:
Auxiliary boiler D; CTG A; CTG B; STG C
Steam conditioner and condensate controller
Legacy contract does not include electricity output

Emissions reported for cogeneration system: 498,643 MT CO₂e
Emissions reported for aux boiler: 63,250 MT CO₂e

Orange = Not part of legacy contract
1: Electricity meter E7 (90,988 MWh)
2: Electricity meter E9 (101,543 MWh)
3: Electricity meter E14 (22,043 MWh)
4: Electricity meter E15 (25,915 MWh)
5: Virtual meter E20 (188,659 MWh)
6: Utility meter SCE 5150 (187,991 MWh)
7: Utility meter SCE 5152 (9,911 MWh)

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Group Participation Exercise 1.4.1: Determining § 95112 Applicability

- Given the following three facilities
 - A. EGU subject to the Acid Rain Program
 - B. Nuclear power plant with diesel-fired emergency generators that emitted 15,000 MT CO₂e
 - C. Geothermal generating facility emitting 14,000 MT CO₂e
- Which of the facilities are subject to reporting under § 95112?
 - A only
 - A and B
 - A and C
 - All of the above

Group Participation Exercise 1.4.1:

Determining § 95112 Applicability - Solution

- Given the following three facilities
 - A. EGU subject to the Acid Rain Program
 - B. Nuclear power plant with diesel-fired emergency generators that emitted 15,000 MT CO₂e
 - C. Geothermal generating facility emitting 14,000 MT CO₂e
- Which of the facilities are subject to reporting under § 95112?
 - A only
 - A and B
 - **A and C**
 - All of the above

Group Participation Exercise 1.4.2: Determining Tier 4 Applicability

Which of these facilities must use the Tier 4 Methodology from 40 CFR 98.33 to calculate CO₂ combustion emissions?

- A. Facility not subject to Part 75
- B. Facility not subject to Part 75 and required by air district to operate CO₂ CEMS
- C. Facility subject to Part 75

Group Participation Exercise 1.4.2:

Determining Tier 4 Applicability - Solution

Which of these facilities must use the Tier 4 Methodology from 40 CFR 98.33 to calculate CO₂ combustion emissions?

- A. Facility not subject to Part 75
- **B. Facility not subject to Part 75 and required by air district to operate CO₂ CEMS**
- C. Facility subject to Part 75

Group Participation Exercise 1.4.3: Cogeneration Facility Reporting

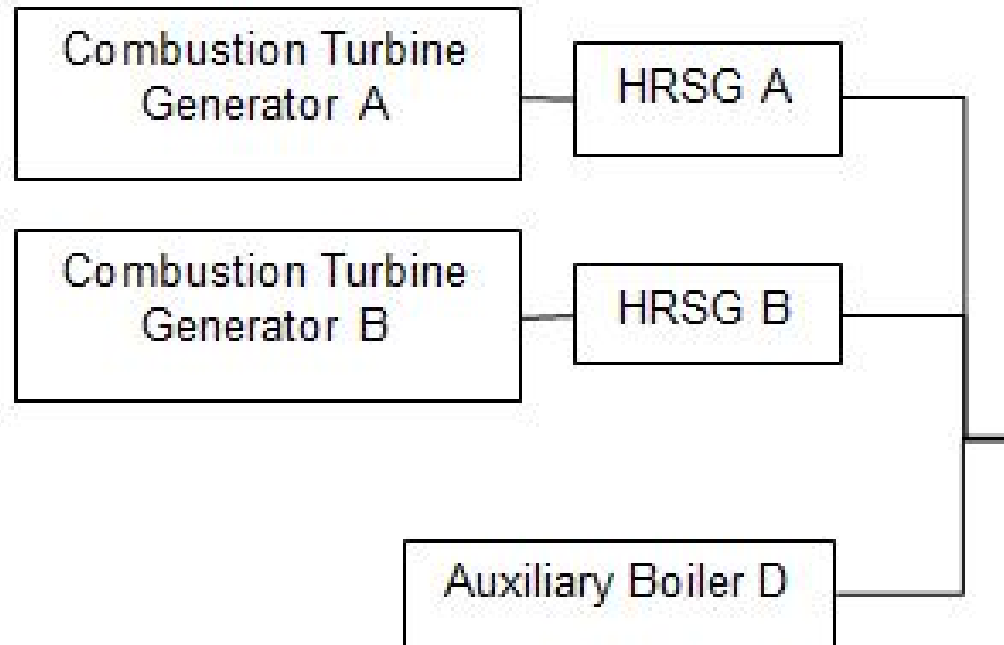
- A facility with a topping cycle cogeneration unit provides steam to an off-site thermal host. The facility also operates a separate simple cycle natural gas turbine that is subject to Part 75. The turbine represents 28% of the annual emissions.
- Under which subpart(s) should emissions be reported?
 - Subpart C
 - Subpart D
 - Subparts C and D
 - None of the above

Group Participation Exercise 1.4.3: Cogeneration Facility Reporting - Solution

- A facility with a topping cycle cogeneration unit provides steam to an off-site thermal host. The facility also operates a separate simple cycle natural gas turbine that is subject to Part 75. The turbine represents 28% of the annual emissions.
- Under which subpart(s) should emissions be reported?
 - Subpart C
 - Subpart D
 - **Subparts C and D**
 - None of the above

Group Participation Exercise 1.4.4: Energy Disposition

See Handouts 1.4.1: Energy Disposition and
1.4.2: Sample Cogeneration Emissions Data Report



Comprehensive Case Study

- Handout 1.4.3, Comprehensive Case Study (Moo Cow) with recommendations and answers
 - Physical handout during class
- Prepare a sampling plan based on Cal e-GGRT report sample
- Facility producing butter and cheese

Questions and ARB Comments

Course 1: General Verification

Complete:

- 1.1 Verification Principles, Requirements, and Procedures
- 1.2 Stationary Fuel Combustion and Sorbent Sources
- 1.3 Accuracy and Product Data
- 1.4 Electricity Generating Units and Cogeneration

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General Errors made by EGUs Identified by Verifiers (1 of 2)

- Inadequate cogen block diagram
 - Missing return condensate
 - Lack of detail for fuel combustion devices
 - Electricity generation system boundary (red box) not included
- Incorrectly aggregated types of emission sources
- Over-estimated parasitic steam use
- Incorrectly identified EGU as cogen when only combined cycle power plant

Other General Errors Identified by Verifiers

(2 of 2)

- Incomplete GHG Monitoring Plan
- Incorrect emission factors and calculation methods
- Excluded flares reported
- Small sources not reported
- Improper use of missing data
- Fuel bill was not pro-rated
- Monthly fuel sampling not conducted
- Sorbent improperly classified or misreported
- Incorrect biomass fuel classification
(urban, ag, forest-derived)