



Output-Based Regulation: Best Practices

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Overview

- What is output-based regulation?
- Why apply output-based regulation?
- How to implement output-based regulation?
- Who has implemented output-based regulation?

What is Output-Based Regulation?

- Regulation that relates emissions to the productive output of a device or process.
 - Unit of emissions/unit of output
 - lb emission/MWh
- Can be applied for any process
 - Our focus is the power/large boiler sector

Why Output-Based Regulation?

- Recognizes and rewards efficiency, which translates to:
 - Reduced fuel consumption (multimedia and energy security impacts)
 - Multi-emission reductions
- Provides a common basis for comparison - apples to apples.
- Relates cost (pollution) to benefit (productive output).

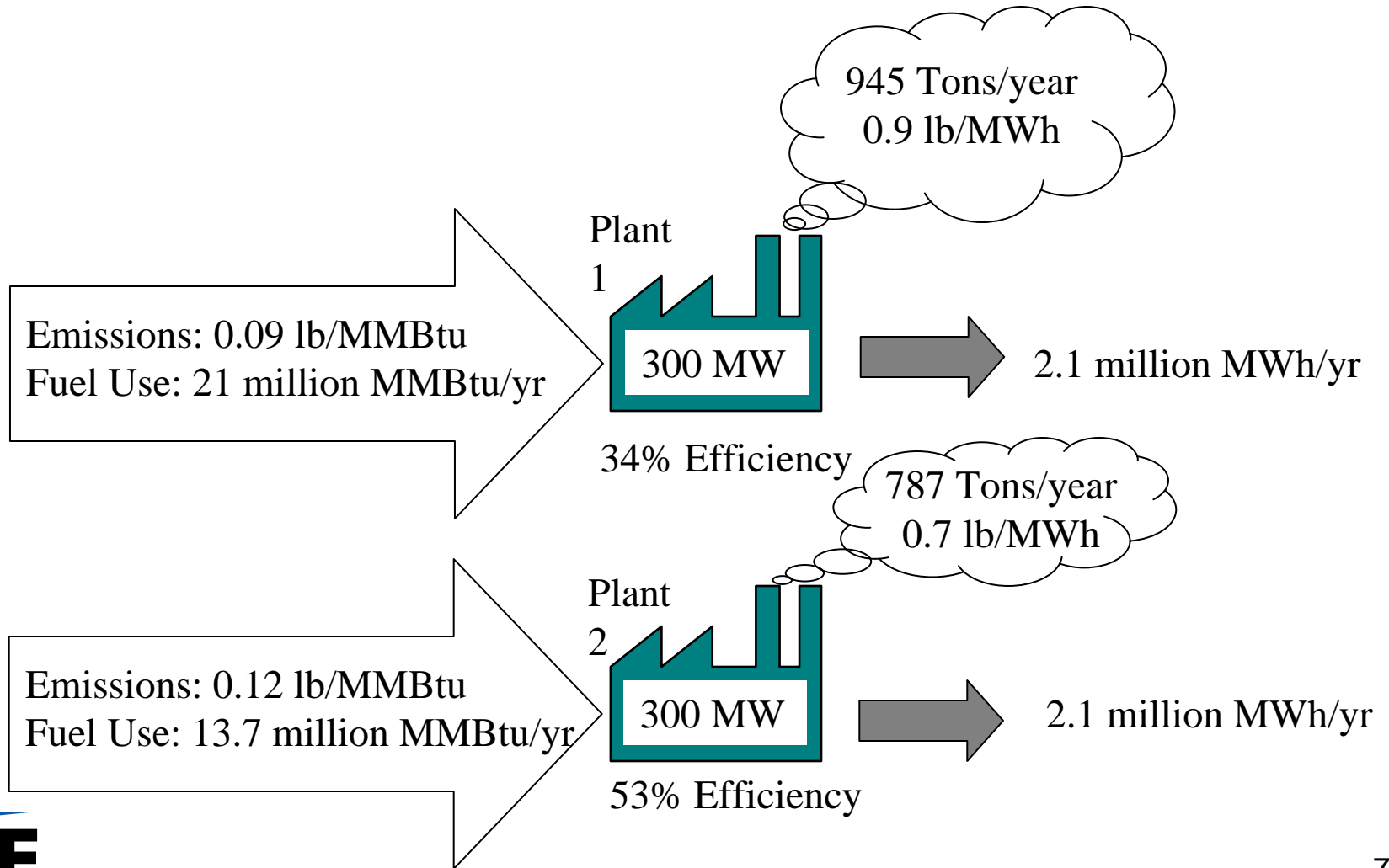
Efficiency as a Pollution Control Measure

- Reduces all emissions, including non-regulated and greenhouse gases.
- It's always “on”. No start-up, shut-down or malfunction interruptions.
- Provides additional options for emission reduction.
- Makes emission reduction more cost-effective.

Conventional Rate Limits

- Output-based regulation allows and encourages efficiency to be used as a control option.
 - Combustion efficiency
 - Reduced parasitic loads
 - Generator efficiency
- Links emissions to productive output.

Benefits of Output-Based Regulation

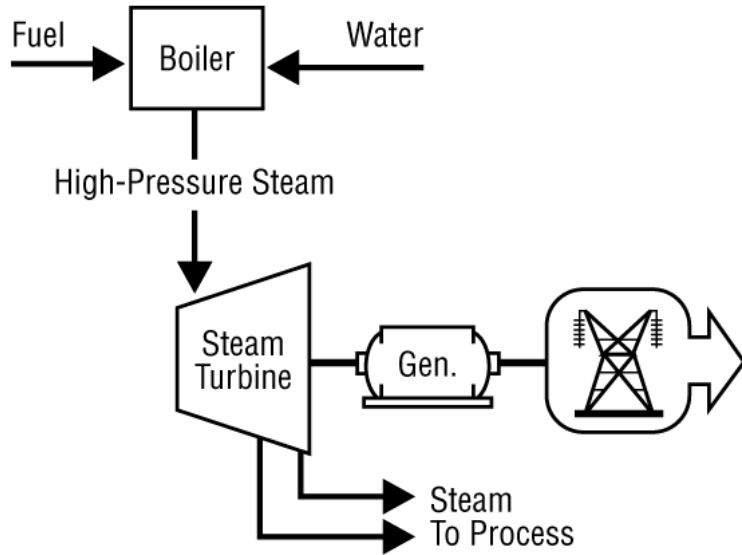


Example: CHP

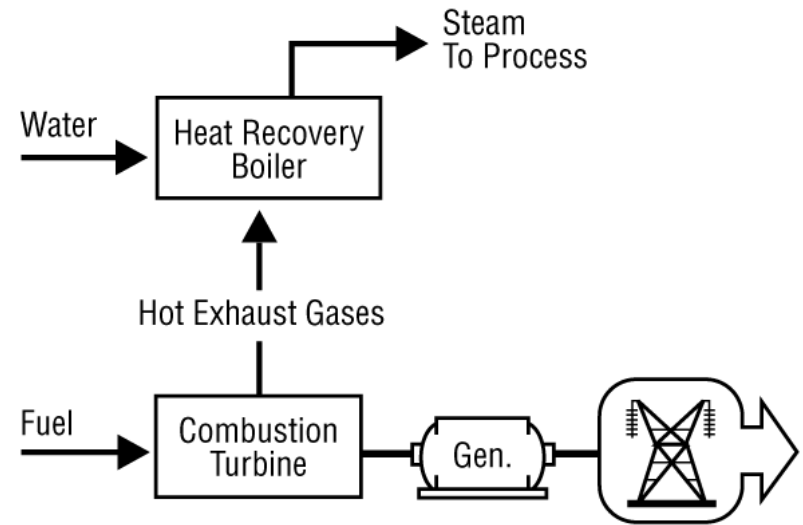
- Combined Heat and Power is the generation of electricity and heat sequentially from the same heat input.
- Electricity primarily used on-site, but some can be sold back to grid. Grid can serve as back-up or swing provider.
- Thermal energy used for heating/cooling or process applications.

Typical CHP Systems

Steam Boiler/Steam Turbine:



Gas Turbine or Engine/Heat Recovery Unit:



Advantages of CHP

- CHP is more efficient than separate generation of electricity and heat.
- Higher efficiency translates to lower cost.
- Use of waste or byproduct fuel, where available, further reduces cost.
- On-site electric generation avoids distribution costs, a significant component of grid electricity price.
- Increased reliability and power quality can also add significant value.

Valuing CHP – Use of Output Based Regs

- Conventional air regulation does not encourage CHP and can discourage it.
 - Promotes capital investment in tailpipe controls over new process technology.
- Output-based regulation is a key tool in recognizing and rewarding CHP.

How to Implement Output-Based Regulation

- Develop the output-based emission limits
- Specify a gross vs. net energy output
- Specify compliance measurement methods
- Specify how to calculate emission rates for CHP units

Development of Limits

- In the near term, we start with input-based limits and convert units to output format.
 - Power generation: lb/MMBtu, ppm or g/bhp-hr → lb/MWh;
 - Industrial boilers: lb/MMBtu_{input} → lb/MMBtu_{output}
 - Requires unit conversions and efficiency factor.
- Ideally, limits will be based on output-based measurements.
 - Output-based limits allow for uniform and direct comparisons.

Net vs. Gross Output

- “Net” output deducts internal loads and losses.
- “Gross” output is total output of a process, i.e. at the generator terminals
- Use of net is closer to policy goal of recognizing overall efficiency.
- Calculation of net can be complicated for large power plants.
- Tradeoff must be made between policy goal and complexity.

Compliance Measurement

- Emission measurement is the same regardless of rule format.
- Output measurement may require new procedures but there are no fundamental barriers.
- Output is often measured as part of plant business (selling the product).

Output Measurement

- Electricity output is easily measured and often measured for commercial purposes.
- Thermal output of large boilers is often measured for plant operation purposes.
- CHP facilities often measure thermal output for sales purposes.
- *The technology is available.*

Two Approaches for Calculation

- CHP provides electric and thermal service with higher efficiency and lower emissions than conventional separate systems.
- Multiple outputs (heat and power) must be addressed. Options are as follows -
- Add thermal output to electric output to reduce effective emission rate. (NSPS, CA, TX)
- Calculate credit for avoided thermal generator (boiler). (RAP Model Rule)
- First option is simpler. Second option more directly reflects actual emission benefits.

1st Approach: Thermal Output

- Set basic standard in lb/MWh.
- For CHP system, compliance is calculated as:
 $\text{emissions}/(\text{MWh}_e + \text{MWh}_{th})$
- Some regulations allow only partial thermal credit.
- Impact is primarily a function of system design (P/H).

2nd Approach: Displaced Emissions

- Set basic standard in lb/MWh.
- For CHP system, compliance is calculated as:
(emissions - avoided emissions)/MWh
- Avoided emissions are the emissions that would have been created by a boiler providing the same thermal output.
- Reflects actual environmental benefits.

Examples of Output-Based Regulation

- Conventional rate limits (EPA NSPS for utility boilers - uniform output-based limit with credit for CHP)
- Distributed generation (Texas general permit for DG - output-based NO_x limits and full thermal credit for CHP; RAP Model Rule - Output-based limits for NO_x , CO, PM with emission credit for CHP)
- Multi-pollutant programs (Massachusetts & New Hampshire, and past federal proposals like the Dingell-Boucher climate change bill, which allocate allowances to industrial stationary sources on an output-basis)
- Generation performance standards (MA, then CA & WA state have implemented output-based standards to control CO_2 emissions; federal GHG proposals often contain performance standards for new power plants – Boxer-Lieberman-Warner bill)
- Allowance allocation (NO_x SIP Call – CT, MA, NH, NJ, then CAIR proposed output – CT, IL, MA, NJ, WI and others; RGGI set-aside – CT)

Output-Based GHG Regulations

- GHG policymaking on the state/regional/federal level is accelerating.
- A number of proposals and/or enacted regulations use output-based allocations, examples include the following:
 - Allowance Allocations – CT’s RGGI regulations; possibly WCI & MGGRA states.
 - Performance Standards – power plant CO2 limits CA, WA, & MA; federal proposals – Boxer-Lieberman-Warner (tied to CCS incentives); Dingell-Boucher.
 - Many opportunities exist to apply output-based standards for GHGs.

Resources:

- RAP Model Rule, “Model Regulations for the Output of Specified Air Emissions from Smaller-Scale Electric Generation Resources,”
(<http://www.raponline.org/ProjDocs/DREmsRul/Collfile/ModelEmissionsRule.pdf>)
- EPA’s “Output-Based Regulations: A Handbook for Air Regulators,”
(http://www.epa.gov/chp/documents/obr_final_9105.pdf)

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