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Output-Based Regulations: Best Practices Option for CHP

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Presentation Outline

- Concept
- Comparison to conventional standards
- Application to CHP
- Current Federal Applications
- Current State Practices
- Elements of a successful OBR Policy

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Concept

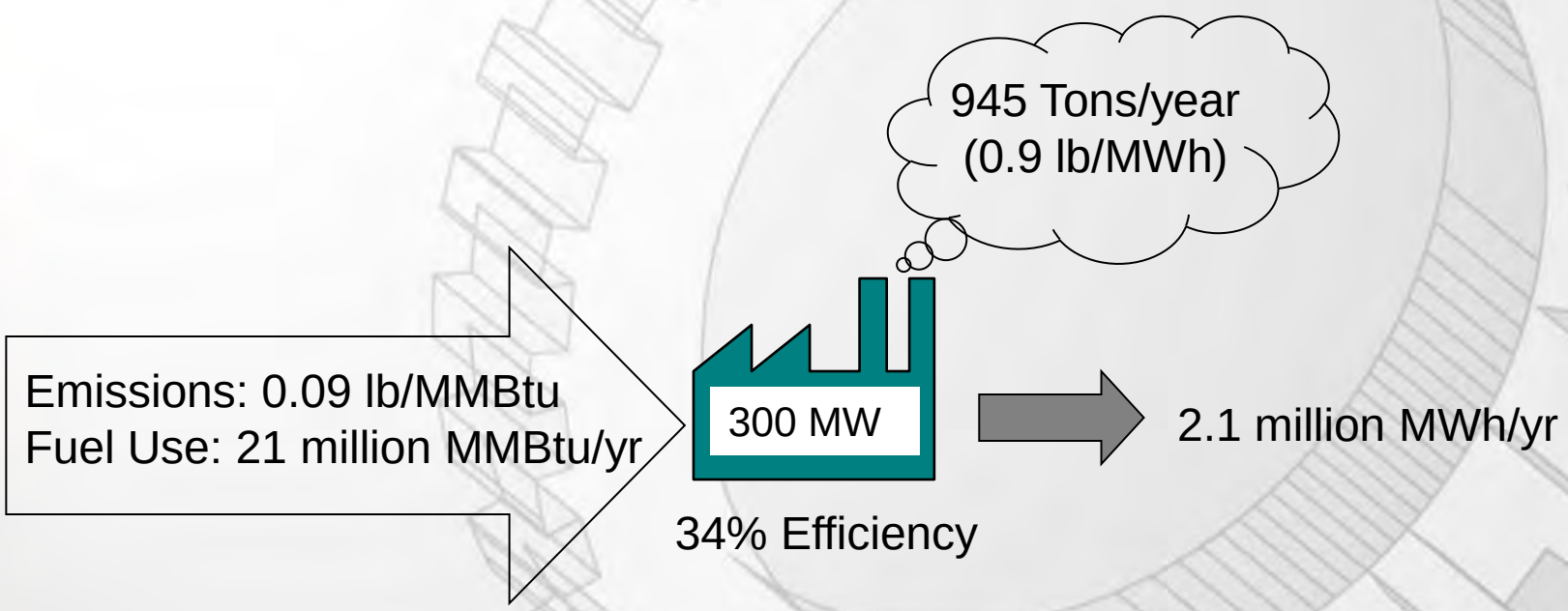
- What are output based regulations ?
  - Regulations that relate emissions to the productive output of a device or process.
    - Unit of emissions/unit of output
    - lb emission/MWh
  - Can be applied for any process
    - Our focus is CHP (the power/electric generating sector)

Concept

- Why apply output based regulations ?
  - Recognizes and rewards efficiency, which translates to:
    - Reduced fuel consumption (multimedia and energy security impacts)
    - Multi-emission reductions
  - Relates cost (pollution control) to benefit (productive output):
    - The use of energy efficiency as part of an emissions control strategy allows additional compliance options. Enables a plant operator to determine the most cost-effective way to reduce emissions. Provides an incentive to use less fuel.

Comparison to Conventional Standards

Plant 1 – Conventional input-based approach



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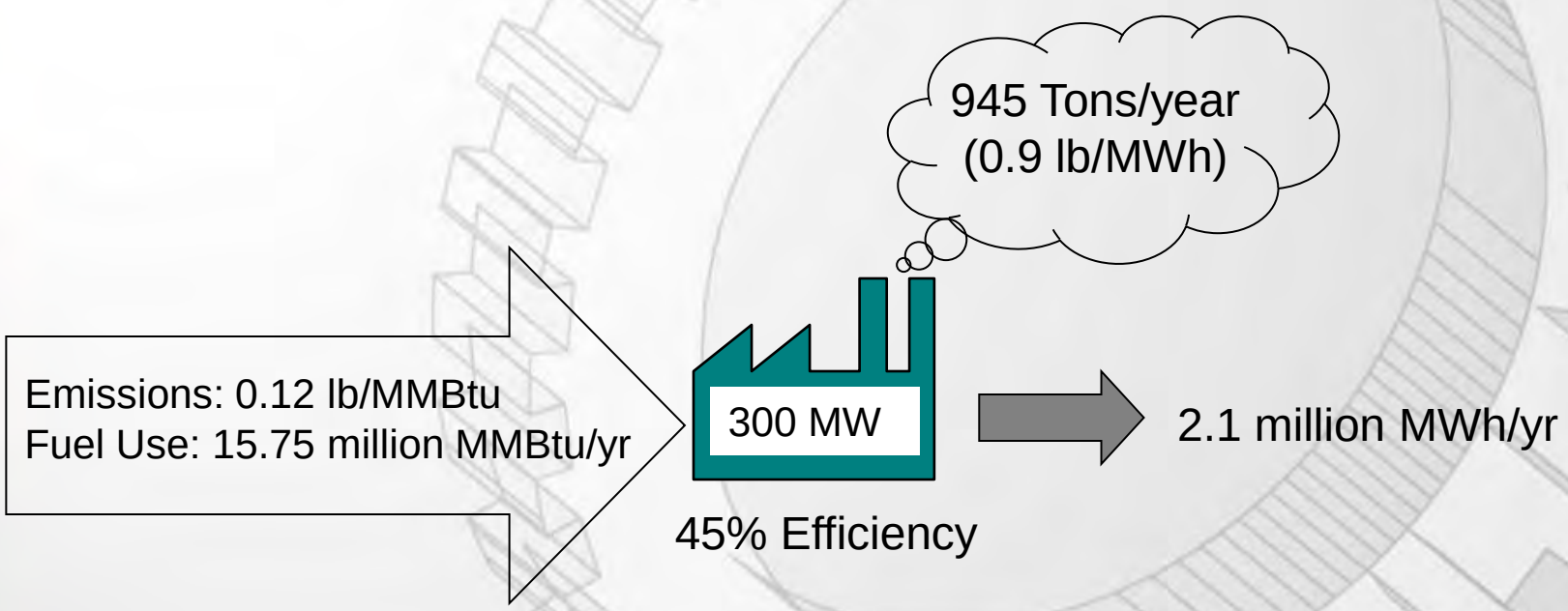
Comparison to Conventional Standards

Plant 2 – output-based approach



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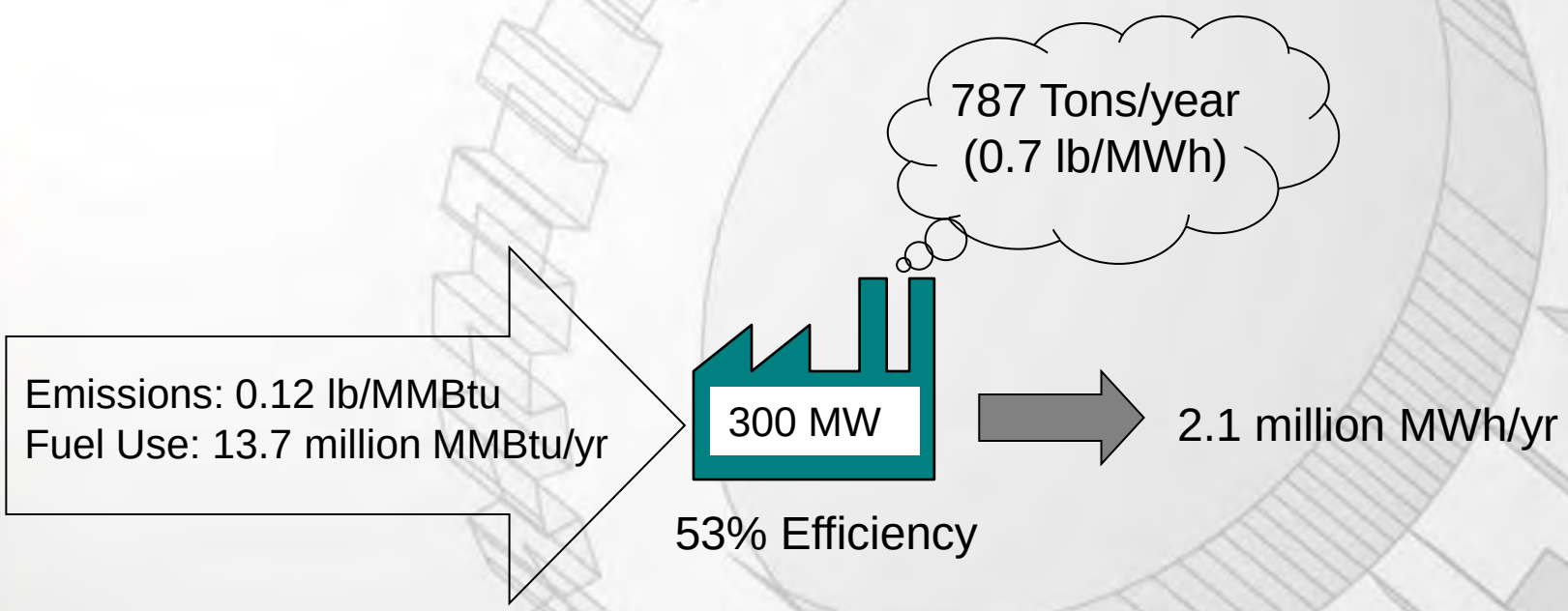
Comparison to Conventional Standards

Plant 3 – output-based approach



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Comparison to Conventional Standards

	Plant 1	Plant 2	Plant 3
Base Unit (MW)	300	300	300
Total Output (million MWh/yr)	2.1	2.1	2.1
Fuel Use (10^6 mmBtu/yr)	21	15.75	13.7
Total Emissions (tpy)	945	945	787
Input-Based limit (lb/mmBtu)	0.09	0.12	0.12
Efficiency	34	45	53
Output-Based limit (lb/MWh)	0.9	0.9	0.7

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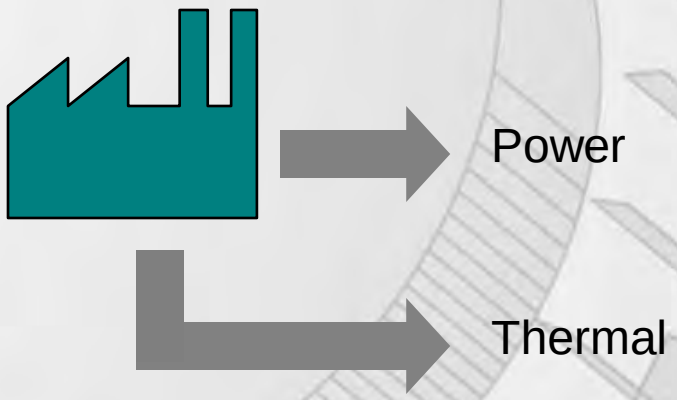
Combined Heat and Power and OBR

- Combined heat and power is the generation of electricity and useful thermal energy from the same heat input – *two or more useful outputs*.
- Electricity primarily used on-site, but excess can be sold back to the grid; Grid provides supplemental and back-up power.
- Thermal output used for heating/cooling or process applications.



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Value of OBR to CHP

- Conventional input-based approaches to air regulations does not encourage CHP
  - Can promote capital investment in tailpipe controls over new process technology and CHP
- Output-based regulation is a key tool in recognizing and rewarding CHP
- Requires recognition of all useful outputs from the system

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Application of OBR to CHP

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

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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 ultimately 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 CHP 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 (e.g., 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:

  CHP emissions/(MWh_e + 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:
  (CHP emissions – avoided emissions)/MWhe
- Avoided emissions are the emissions that would have been created by a boiler providing the same thermal output.
- Reflects actual environmental benefits.

Current Federal Applications

- Climate change bills with output-based performance standards for new power plants (e.g., Boxer-Lieberman-Warner Climate Security Act (S. 3036)).
- EPA also issued air toxics standards for boilers (often referred to as the "boiler MACT") in February 2011 that included an output-based emissions standard as an option (the standards are being reconsidered as of June 2011 while EPA seeks and reviews additional public input on new standards)
- New Source Performance Standards (NSPS)
    - Utility and industrial boiler NSPS, February 2006
    - Stationary combustion turbine NSPS (Subpart KKKK), July 2006
    - Reciprocating internal combustion engine, NSPS, July 11, 2006 (compression ignition) and January 18, 2008 (spark ignition)

Current State Practices

State	Conventional Emissions Limits	Small DG Rule	Allowance Trading	Allowance Set-Asides	Emissions Performance Standard (EPS)
Arkansas			X*		
California	X*	X*			X
Connecticut		X*	X*	X*	X
Delaware	X*				
Illinois			X*	X*	
Indiana			X	X	
Maine	X				
Massachusetts	X	X	X*	X	X*
Missouri			X*	X*	
New Hampshire	X				
New Jersey			X*	X*	
New York		X (proposed)			
Ohio			X*		
Oregon					X
Pennsylvania			X*		
Rhode Island	X*				
Texas		X*			
Washington					X
Wisconsin			X*		

Note: *Includes recognition of CHP through accounting for thermal output.

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Conventional Emission Limits

- **California.** California has set output-based emissions limits (NOx, CO, VOCs, and PM) for DG units in the state. The standards include a separate limit for DG units. The DG limit applies to CHP and accounts for both electrical and useful thermal output For information on the DG certification program see, http://www.arb.ca.gov/regact/dg06/finalfro.pdf
- Other examples – Texas

Small DG Policy

- **Connecticut.** Connecticut has promulgated an OBR for NOx, particulate matter, CO, and CO_2 from small DG (< 15 MW capacity), including CHP. Connecticut's regulation recognizes the efficiency of CHP by accounting for both the electrical and useful thermal output of the systems. For information on Connecticut's DG rule see, http://www.ct.gov/dep/lib/dep/air/regulations/mainregs/sec42.pdf

Allowance Trading

- **Massachusetts.** The Massachusetts NOx cap and trade program (under CAIR), 310 CMR 7.32 employed useful output, including the thermal output of CHP, to allocate emissions allowances to affected sources (generators > 25 MW). For more information on the state's CAIR regulations visit http://www.mass.gov/dep/air/laws/cairfnl.pdf

Allowance Set-Asides

- **Indiana.** Indiana's NOx trading program as part of the Clean Air Interstate Rule (CAIR) includes a set-aside of allowance allocations for energy efficiency and renewable energy. Indiana allocates 999 tons of NOx allowances each year for projects that reduce the consumption of electricity, reduce the consumption of energy other than electricity, or generate electricity using renewable energy. Eligible technologies include combined cycle systems, CHP, microturbines, and fuel cells. For more information, visit http://www.in.gov/legislative/iac/T03260/A00240.PDF

Emissions Performance Standards (EPS)

- **California, Oregon, and Washington.** These states apply output-based standards to control CO_2 emissions from power plants. The standard for all three states is 1,100 lbs of CO_2/MWh. Also, Massachusetts under its earlier multi-pollutant regulations for power plants set an output-based standard of 1,800 lbs of CO_2/MWh. For information on the CO_2 emissions performance standard, please see, http://www.energy.ca.gov/emission_standards/index.html.

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Elements of a Successful OBR Policy

- Educate state environmental regulators on OBR and CHP.
- Evaluate the state's overall air pollution regulatory program.
- Coordinate with other state agencies that can lend support.
- Determine what types of DG and CHP technologies and applications might be affected and whether there are any specific technology issues that the regulation needs to address.
- Gather/review available output-based emission data for regulated sources.
- Evaluate alternative approaches to account for multiple outputs of CHP units.
- Train permit writers on implementation of the new rules, once adopted.

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Considerations in air regulations

- The choice of thermal output accounting
- Compliance and monitoring requirements
  - In the NSPS for stationary combustion turbines, Subpart KKKK,
    - Compliance requirements (for NOx) – annual performance test or the use of CEM or parametric tests
    - Monitoring requirements (for NOx) – install and operate a continuous monitoring system to monitor and record the fuel consumption and ratio of water or steam to fuel being fired in the turbine.

Contact Information

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Output-Based Regulations Resources:
http://www.epa.gov/chp/state-policy/output.html

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