IGCC Environmental Performance: A Review of Air Emission Rates for U.S. IGCC Projects in Development

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Discussion Topics

- Air emission controls for IGCC
- New Federal regulatory requirements
- Impacts of the Energy Policy Act of 2005
- Emission rate units
- Air permitting issues
- Comparisons of emission rates for proposed IGCC units

Technology Comparison

	PC	IGCC
Feedstock	-	Coal
Fuel	Coal	Syngas
Combustion	Coal in boiler	Syngas in gas turbine
Emission Controls	Post-combustion clean-up of large volume of exhaust gas	Pre-combustion clean-up of small volume of syngas

IGCC – Sulfur Removal

- Gasification occurs in a reducing atmosphere (oxygen-starved)
- Sulfur compounds are liberated as H_2S and COS, not SO_2
- H_2S/COS removed by refinery industry technologies to levels ≥99%
- H_2S/COS remaining in the syngas is burned in the gas turbine and becomes SO_2 in the HRSG exhaust

IGCC – NOx Removal

- Controlled by saturating syngas with water and injecting N_2 with syngas (dilutes and cools the flame and reduces thermal NOx)
- CO_2 in syngas stream also acts as a diluent
- Use diffusion burners vs dry low NOx burners used in NGCC
- Selective Catalytic Reduction (SCR) is an option for additional NOx removal

Comparison of Air Emission Controls

	SO_2	NOx	PM	Mercury
PC	FGD system	Low-NOx burners and SCR	ESP or baghouse	Inject activated carbon into flue gas
IGCC	AGR system removes H_2S from syngas	Syngas saturation and N_2 diluent; SCR option	Wet scrubber, high temperature cyclone, ceramic filter	Syngas flows through carbon bed

What Regulations Apply to IGCC?

New Source Performance Standards

- Final EPA regulations, June 2007
- IGCC is covered under Subpart Da as an Electric Utility Steam Generating Unit (just like PC boilers) if:

  "The combined cycle gas turbine is designed and intended to burn fuels containing 50 percent (by heat input) or more solid-derived fuel not meeting the definition of natural gas on a 12-month rolling average basis"

- No longer covered by Subpart KKKK, even when natural gas is used

New Source Performance Standards for IGCC

Emission	NSPS	NSPS on Gasifier Input Basis (calculated)
NOx	1.0 lb/MWh*	0.143 lb/MMBtu
SO_2	1.4 lb/MWh* and minimum 95% removal	0.2 lb/MMBtu
Particulate Matter	Lesser of 0.14 lb/MWh* or 0.015 lb/MMBtu**	0.011 lb/MMBtu
Mercury	20 x 10^{-6} lb/MWh*	2.87 lb/TBtu

***Output-based standards are on a gross generation basis**

**** Gas turbine heat input basis, filterable PM only**

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Energy Policy Act of 2005
Air Emission Limits

Parameter	Loan Guarantee	Tax Credit
SO_2	0.05 lb/MMBtu	99% removal or 0.04 lb/MMBtu
NOx	0.08 lb/MMBtu	0.07 lb/MMBtu
Particulate Matter	0.01 lb/MMBtu	0.015 lbs/MMBtu
Mercury	90% removal rate (including fuel pretreatment) of mercury from the coal-derived gas and any other fuel, combusted by the project	90% removal

Emission Rate Units

- Industry desire to compare coal-based IGCC to PC
- Some IGCC permits list emission rates in lb/MMBtu of gasifier (coal) heat input
- Others list emission rates on gas turbine heat input basis (like NGCC)
- EPA's comments on the new NSPS addressed this:
  - *"The heat input for an IGCC facility is the heat content of the syngas burned in the stationary combustion turbine and not the heat content of the coal fed to the gasification facility. The gasification facility is not part of the affected source under subpart Da, only the stationary combustion turbine (turbine and heat recovery steam generator) are covered."* (emphasis added)

Emission Rate Units

- Emission rates are to be expressed on basis of syngas input to the gas turbine
- Permit applications or permits can list "equivalents" on gasifier input basis, as well as lb/hr and ppm
- Important to specify heat input basis in permit application

Emission Rate Units
NOx Example

NOx Emissions from Gas Turbine	Emission Rate Gasifier (Coal) Input Basis	Emission Rate Gas Turbine (Syngas) Input Basis
161 lb/hr	0.059 lb/MMBtu	0.077 lb/MMBtu

30% difference!

Permitting an IGCC Plant

Include All Potential Feedstocks in Permit Application

- IGCC doesn't necessarily infer coal gasification
- Example: "The facility will process the following feedstocks or blends of feedstocks, converting them to syngas"
  - Bituminous coal
  - Powder River Basin sub-bituminous coal
  - Petroleum coke
  - Biomass
  - Blends of the above feedstocks

Air Permitting

- Same HRSG stack emission points as NGCC
- Same fugitive dust issues as PC
  - Haul roads, coal delivery, unloading and handling
- Similar air permitting requirements
  - Air dispersion modeling
  - BACT analysis
  - Emission controls determination

Air Emissions

- Unique emission points depend on technology provider
  - Flare
  - Sulfur Recovery Unit tail gas incinerator
  - Sulfuric Acid Plant stack
  - Tank vent incinerators
  - ASU cooling tower

Air Permitting: Lessons Learned

- For air permit application:
  - Preliminary engineering required to provide sufficient information for permit application
  - Emission inventory has to be developed
  - Startup, shutdown and emergency emissions must be calculated for ambient air quality modeling
  - Emissions from flare must be determined
    - Raw syngas
    - Clean syngas
    - Duration
    - Number of flare events/year

What About SCR for IGCC?

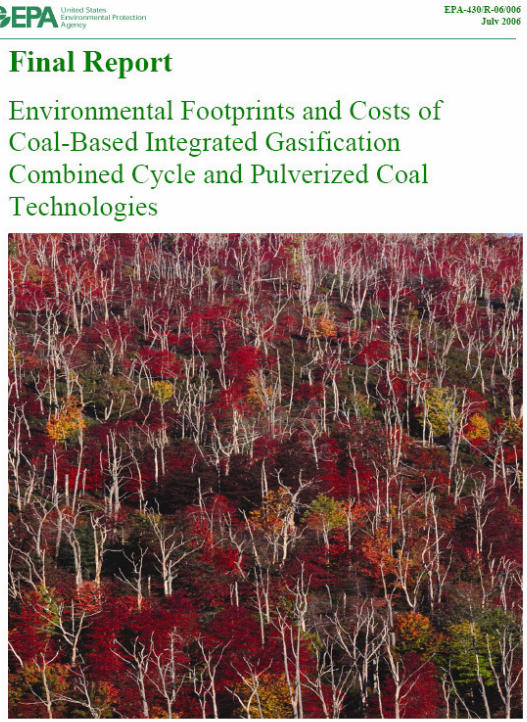
- Technical issues
  - The fuel is syngas, not natural gas as in NGCC
  - Ammonium sulfate/bisulfate deposit in the HRSG, causing corrosion and plugging, and may require excessive shutdowns for washing
  - No coal-based IGCC plant uses SCR
- Economic Issues
  - SCR use would require deeper sulfur removal, i.e. Selexol, at higher capital cost
  - No long-term commercial guarantees available yet for operation with coal-based syngas

Use of SCR on IGCC Plants

- SCR has been proposed on some units:
  - As BACT for NOx
  - As an Innovative Control Technology to reduce emissions beyond diluent injection
  - As a trial/experiment, with emission limits only for natural gas use
  - To evaluate SCR as part of DOE demonstration program with a syngas-fired combined cycle unit
  - To minimize NOx emissions in order to reduce costs for NOx allowances

Use of SCR on IGCC Plants

- EPA addressed SCR in 2006 report
- Noted technical problems with using SCR on IGCC plant
  - Noted SCR issues with IGCC plants using liquid feedstocks
  - Evaluated SCR w/Selexol for deep sulfur removal
- Concluded that:
  - Even w/Selexol, SCR problems are not solved
  - Additional cost and reduced output are negative impacts to IGCC
  - BACT will continue to be a case-by-case issue



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Permitting an IGCC Plant

With only two commercial-sized IGCC plants in the U.S……..

Polk Power Station

Wabash River Station

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Working with Regulatory Agencies

- Most agency staff have experience with permitting NGCC plants over the last 10-15 years

- Some have worked with PC units

- But what about IGCC plants?

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Regulatory Agency Issues

- State environmental agency staff may not be familiar with the technology and the regulations that cover IGCC
  - It's not PC or NGCC
- Different states treat IGCC differently
- Emission limits need to be evaluated on a consistent basis

Regulatory Agency Issues

- Agencies need up-front education on IGCC technology and the entire project
- Agency staff may need to better understand how IGCC, PC and NGCC are different
- Encourage staff to attend GTC workshops
  - Covers environmental profiles and regulatory issues
  - No attendance fee
  - GTC reimburses agency staff for travel expenses

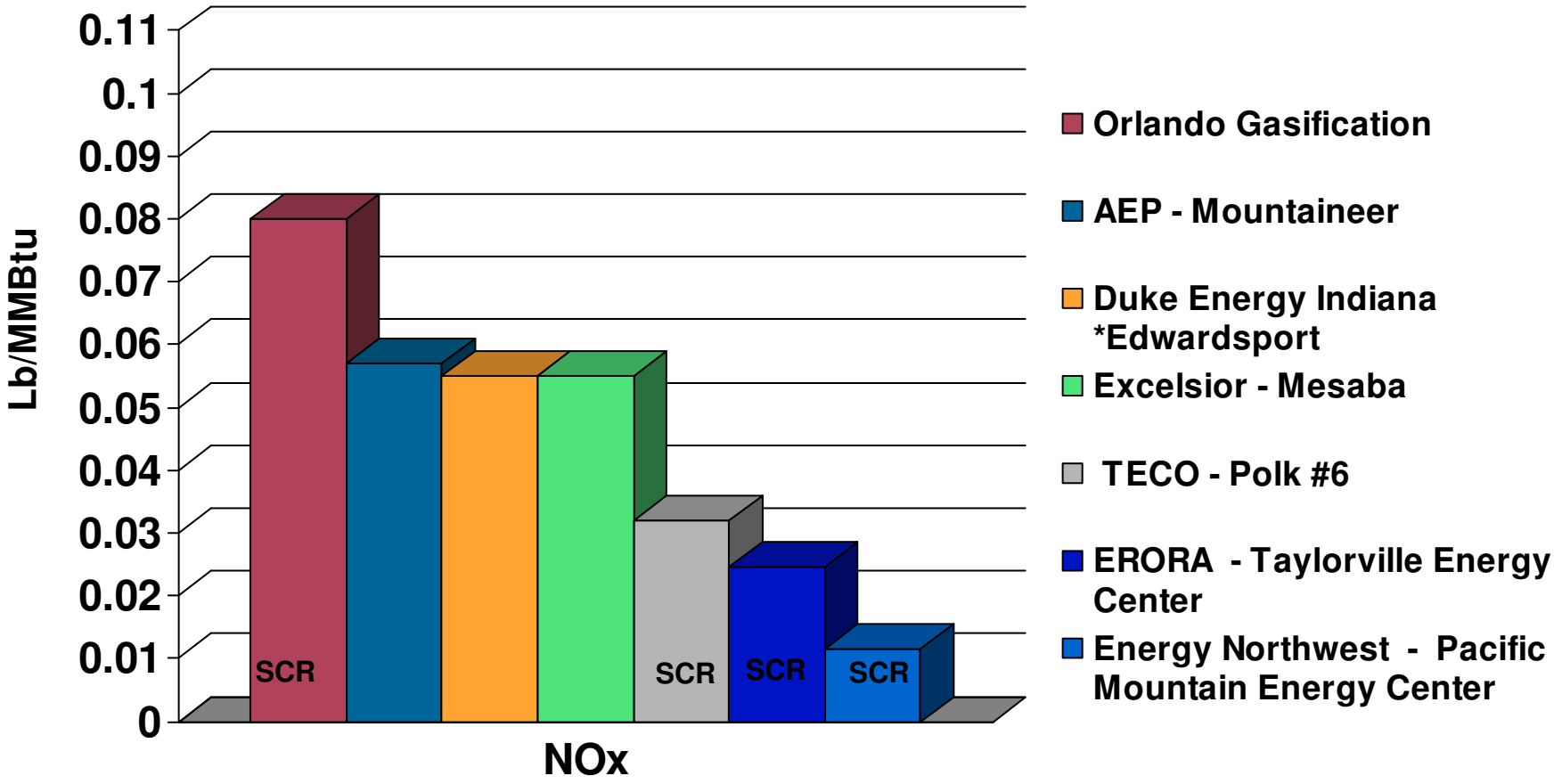
Air Emission Rate Comparisons

- IGCC plants included in charts
  - AEP - Mountaineer: permit application
  - Duke Energy Indiana - Edwardsport: permit application
  - Energy Northwest – Pacific Mountain Energy Center: permit application
  - ERORA – Taylorville Energy Center: final permit
    - Similar rates in draft permit for Cash Creek Generation in KY
  - Excelsior Energy – Mesaba: permit application
  - Orlando Gasification – final permit
  - Tampa Electric Company – Polk Unit #6: permit application

Air Emission Rate Comparisons

- NOx and SO_2 data in this presentation
- Data from publicly available information
  - Permit applications
  - Draft permits
  - Final permits
  - Submittals to other agencies
- Provide data on gasifier and gas turbine heat input bases
  - Calculated when not provided in data sources

NOx Emission Rate Comparisons
Gasifier Heat Input Basis



* Edwardsport will use SCR for natural gas-fired operation

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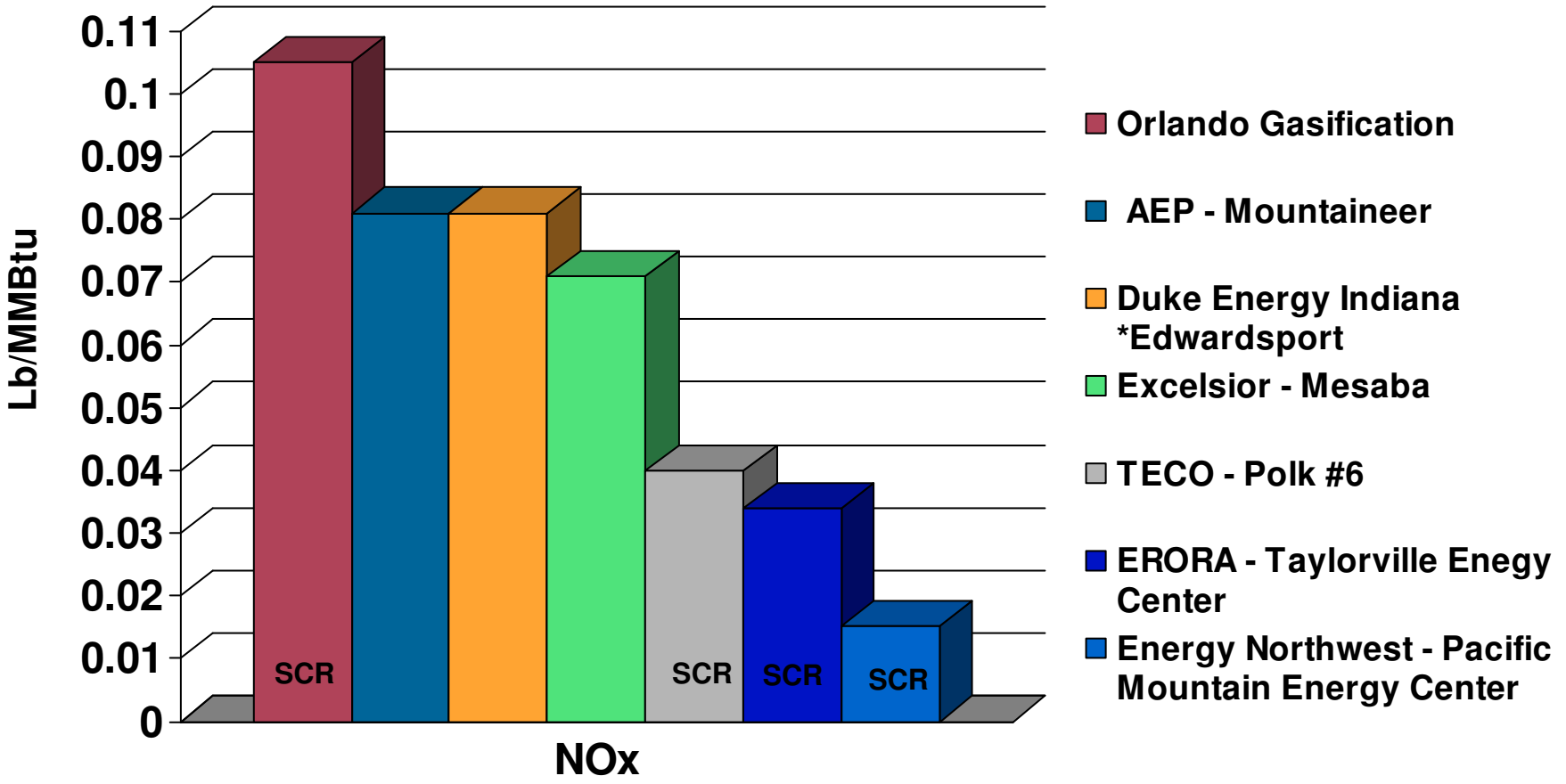
NOx Emission Rate Comparisons
Gas Turbine Heat Input Basis



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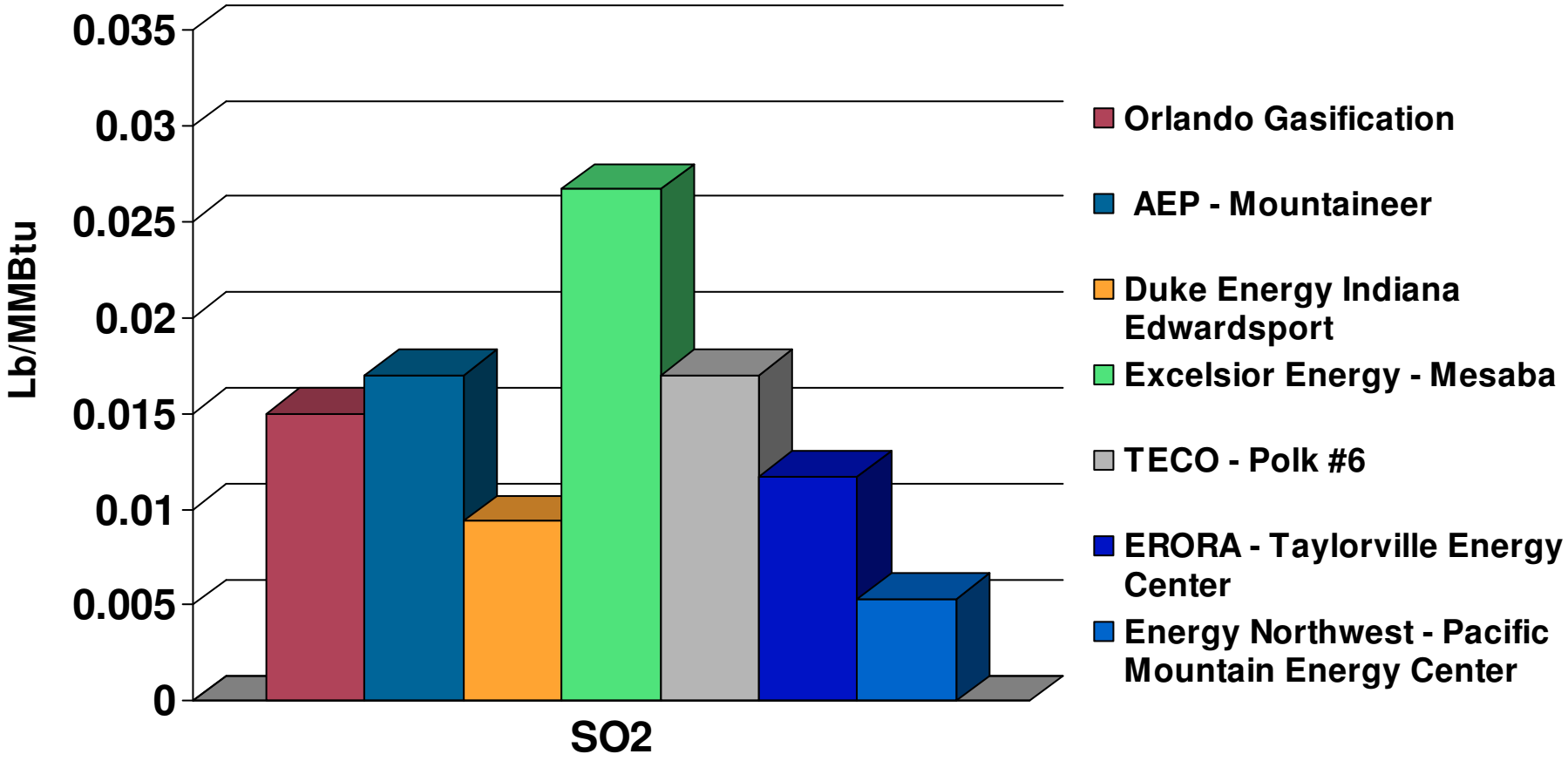
SO_2 Emission Rate Comparisons Gasifier Heat Input Basis



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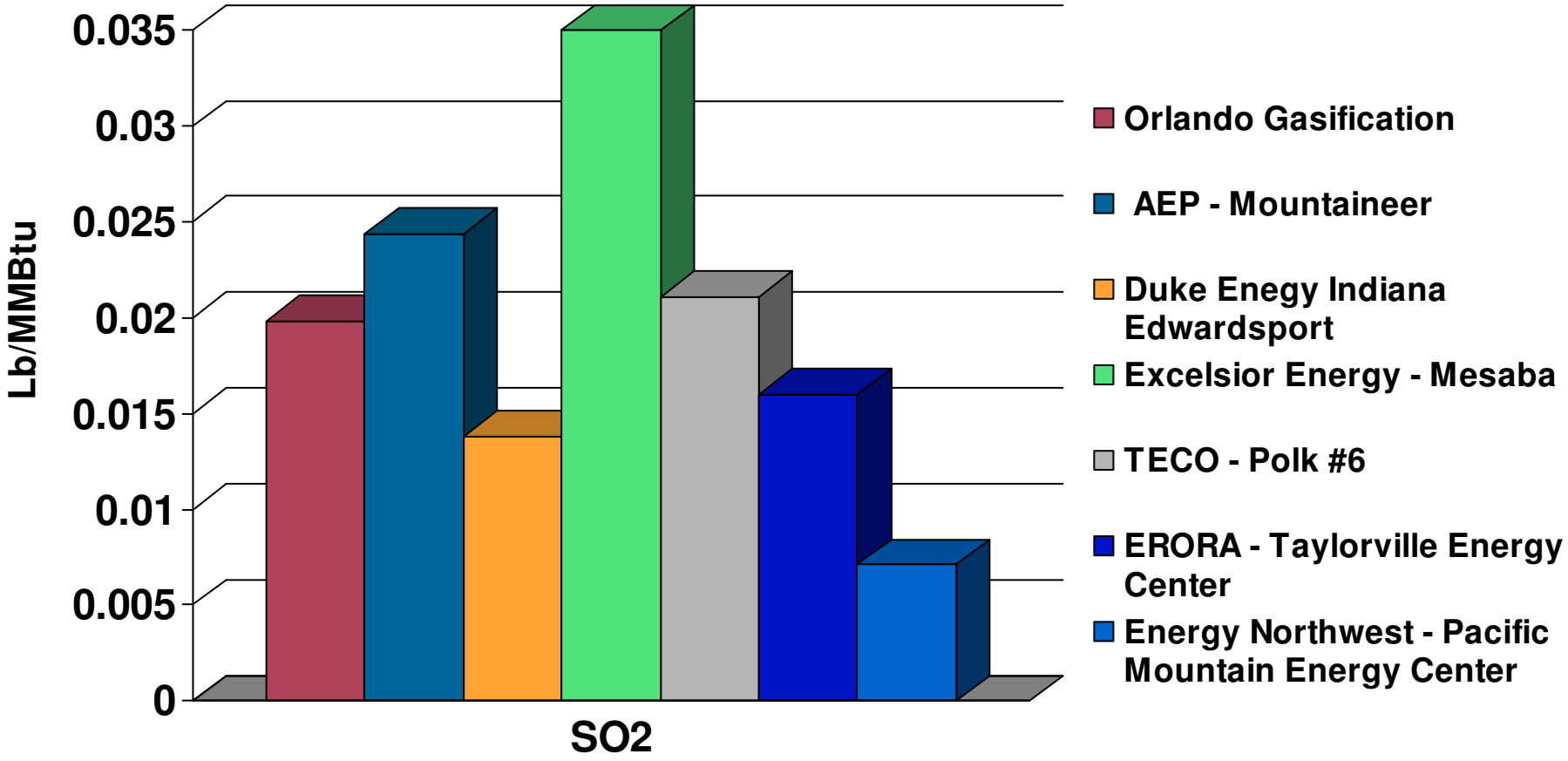
SO_2 Emission Rate Comparisons Gas Turbine Heat Input Basis



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Questions???

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