



# The First Limit – GHG BACT Review

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# GHG BACT Review

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- **Applicability Brief**
- **Key Guidance**
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- **BACT Summary**

# Background - GHG BACT Review

- **As a result of –**
  - Lack of congressional will to regulate GHG emissions;
  - Court case paving the way for USEPA regulation;
  - Endangerment finding by USEPA
- **June 3, 2010 USEPA issued rule that “tailors” the applicability provisions of the Prevention of Significant Deterioration (PSD)**

# Background

- **Permitting based on the potential to emit of GHGs at “large” sources**
  - Potential for PSD Review / BACT limits
  - Title V Operating Permits required
  - Synthetic minor source permitting available

# Applicability Brief - GHG BACT Review

- **PSD applies to GHGs, if,**
  - The source is otherwise subject to PSD (for another regulated NSR pollutant), and
  - The source has a GHG PTE equal to or greater than 75,000 TPY CO<sub>2</sub>e

OR

- The source has a GHG PTE equal to or greater than:
  - 100,000 TPY CO<sub>2</sub>e, and
  - 100/250 TPY mass basis
- **All units in short tons**

# Applicability Brief - GHG BACT Review

“The mass basis calculation for the amount of GHGs determines whether the GHGs are emitted at the major source level, so that GHGs are considered to be emitted at the major source level if they are emitted in an amount that is equals to or greater than 100/250 TPY (depending on the source category) on a mass basis. In contrast, the CO<sub>2</sub>e basis calculation for the amount of GHGs is relevant for determining whether the GHGs are subject to regulation as a regulated NSR pollutant, but not for determining whether GHGs are emitted at the major source level.”

# Applicability Brief - GHG BACT Review

- **CO<sub>2</sub>e is the sum of six GHG compounds and accounts for the global warming potential (GWP)**
  - **carbon dioxide (CO<sub>2</sub>) – GWP 1**
  - **nitrous oxide (N<sub>2</sub>O) – GWP 310**
  - **methane (CH<sub>4</sub>) – GWP 21**
  - **hydrofluorocarbons (HFCs) - Various**
  - **perfluorocarbons (PFCs) - Various**
  - **sulfur hexafluoride (SF<sub>6</sub>) – 23,900**
  - **GWPs found in 40CFR98, Table 1**

Largely  
Combustion  
Related

# Key Guidance

- **PSD and Title V Permitting Guidance for Greenhouse Gases (USEPA Office of Air and Radiation, March 2011)**
- **5-Step Top-Down Process**
  - Step 1: Identify all available control technologies.
  - Step 2: Eliminate technically infeasible options.
  - Step 3: Rank remaining control technologies.
  - Step 4: Evaluate most effective controls and document results.
  - Step 5: Select the BACT.

# Key Guidance

- **Definition of the Source**

- Guidance speaks of “redefining the source”
- Step1 - Identify all available control technologies
- Inherently Lower-Emitting Processes/Practices/Designs,
- Add-on Controls, and
- Combinations of Inherently Lower Emitting Processes/Practices/Designs and Add-on Controls.

# Key Guidance

- **Energy, environmental, and economic impacts considered;**
- **Special consideration given to energy efficiency;**
- **Weigh the impact of reductions with collateral increases in other regulated pollutants;**

# Key Guidance

- **The guidance references enhanced oil recovery as potentially shifting the economics of Carbon Capture and Sequestration (CCS); and**
- **“reasonableness of calculated cost effectiveness values” (in \$/ton of CO<sub>2</sub>e) will evolve over time.**
- **“job loss and the potential movement of production overseas” as an example of impacts on community.**
- **Energy Star reference**

# Case Study – Wolverine Power

- **Wolverine Clean Energy Venture (WCEV)**

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# Case Study – WCEV

- **New petcoke/coal/biomass-fired 600 MW CFB**
- **Rogers City, MI**
- **Final permit issued July 2011**
- **6,024,107 TPY CO<sub>2</sub>e**
- **GHG emissions from fuel combustion and calcination of limestone to lime (in CFB bed)**

# Case Study – WCEV

- **Sources evaluated include the CFB boilers and ancillary oil-fired equipment including:**
  - Auxiliary boiler
  - Black-start generator
  - Emergency Generator
  - Fire Pump
- **Emission Factors from 40CFR98, Table 1**

# Case Study – WCEV

- **Original air permit application submitted in September 2007**
  - BACT review included IGCC comparison
  - Strong permit record establishing project definition
- **Outside of air permit application WCEV included USDOE CCS funding application**
- **Biomass study was commissioned in 2007**

# Case Study – WCEV

## Step 1 – Identify Control Technologies

- **Base generating technology - IGCC and Oxy-Fired Flue-Gas Recycle or Oxy-Fired CO<sub>2</sub> Recycle boiler technology eliminated through permit record**
- **Identified and evaluated**
  - CCS technologies,
  - Biogenic fuel augmentation, and
  - Energy efficiency

# Case Study – WCEV

- **Step 2 – Eliminate Technically Infeasible Options**
- **Step 2 - Rank Remaining Technologies**
  - CCS followed by biomass fuel augmentation and then energy efficiency

# Case Study – WCEV

- **Step 4: Evaluate most effective controls and document results**
  - CCS;
  - Biomass fuel augmentation; and
  - Energy efficiency

# Case Study – WCEV

## Carbon Capture

- Absorption processes (liquid), hybrid solution (mixed physical and chemical solvent), adsorption process (solid surface, ionic liquid),
- Physical separation (membrane, cryogenic separation).
- Biological uptake of CO<sub>2</sub> in algae.

## Sequestration

- Geologic
- Terrestrial

# Case Study – WCEV

## CCS cost based on USDOE funding application

Years	20
Interest Rate	7
Capital Recovery Factor	0.094
Capital Costs	\$ 210,060,000
Fixed O&M (year 2 - 20)	\$ 8,223,000
Variable O&M	\$ 9,663,000
Annual Capital Cost	\$19,828,178
Annualized Cost	\$37,714,178
CO <sub>2</sub> Removed (metric TPY CO <sub>2</sub> e)	300,000
Cost Effectiveness (\$/ton)	126

# Case Study – WCEV

## Relative cost effectiveness

- USEPA's rulemaking "tailored" greenhouse gasses such that 100,000 tons of CO<sub>2</sub>e is equal to 100 tons of a criteria pollutant for the purpose of PSD applicability;
- Criteria pollutant BACT cost effectiveness threshold in the range of \$8,000 per ton, then the CO<sub>2</sub>e equivalent cost effectiveness should be 0.001 times as much:

**\$8/ton controlled**

- Based on this criterion, the CCS demonstration system for WCEV is found to be infeasible based on cost (\$126/ton).

# Case Study – WCEV

## **Biomass co-firing – establish as “carbon neutral”**

- **Tie in the Michigan Renewable Portfolio Standard (Michigan Act 295) with the “sustainably managed forests” provisions in Michigan law (Michigan Act 431 Section 18.1261c)**

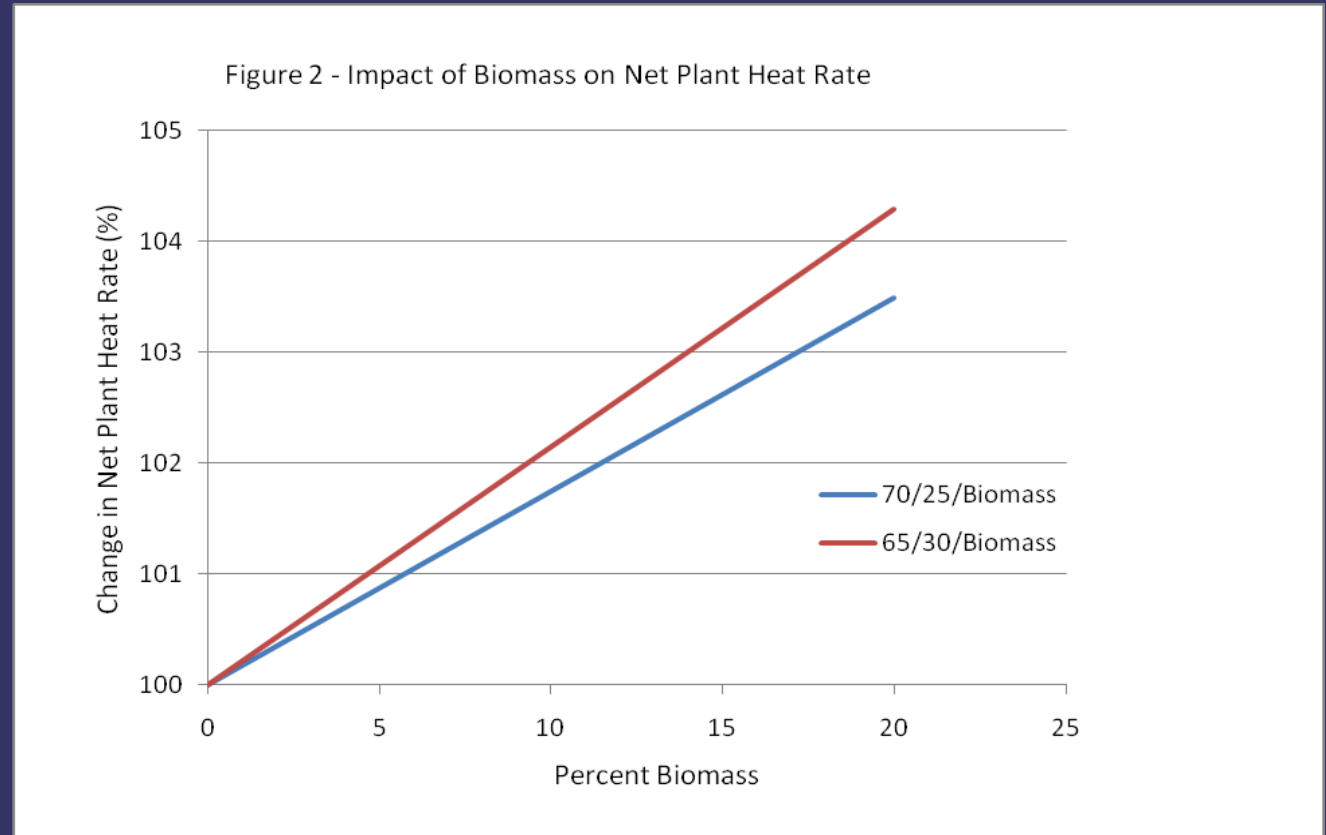
# Case Study – WCEV

## Limiting factors on biomass co-firing

- **Generally, standalone maximum capacity is 50 MW (gross)**
- **Impacts on material handling costs**
- **Impacts on plant gross heat rate**

# Case Study – WCEV

## Affect of Biomass on Net Heat Rate



# Case Study – WCEV

## Energy Efficiency – Supercritical CFB

- **Lagisza Poland**
- **460 MW (gross) supercritical CFB (First of its kind)**
- **Design plant heat rate 7,850 Btu/kWh (HHV, gross)**
- **European bituminous coals without the fuel flexibility of WCEV**
- **Efficiency due to design that would not be possible in the US**
  - Flue gas heat recovery system would preclude the use of a polishing scrubber and SNCR – would not meet BACT
- **Employs once-through cooling system (no can do)**
- **US design of similar unit - approximately 8,270 Btu/kWh (HHV, gross), comparable to the design value of the WCEV units at 8,262 Btu/kWh (HHV, gross)**

# Case Study – WCEV

- **Energy Efficiency**

System Component	~ Load Impact on Gross Capacity	Nature of Impact on Gross Capacity and Heat Rate
Air Pollution Control	3.00%	Due to air pollution control including the polishing scrubber, SNCR, and fabric filter.
Cooling Water	2.00%	Impact related to condenser losses.
Cooling Tower	2.40%	Operation of "closed cycle" cooling as opposed to once through cooling
Major Fans	2.50%	Forced draft, primary air, and induced draft fan operation.
Other	0.10%	Includes material handling, air heater operation, instrument air, and plant thermal and electrical demands.
Total	10%	Approximate

# Case Study – WCEV

- **Specify variable speed motors for all motors over a size threshold,**
- **Minimize the pressure drop across the air pollution control devices,**
- **Maximize the thermal performance of heat transfer components both for insulation and heat exchange, and**
- **Follow the manufacturers' operation and maintenance guidelines for energy consuming plant components.**

# BACT Summary - WCEV

- **Minimum of 5% biomass (heat input basis per year)**
- **All motor over 100 Hp shall be variable speed**
- **All APC devices shall be operated at the minimum pressure drop**
- **Thermal performance components shall be designed to maximize energy efficiency**
- **Where practical energy efficiency of all fans, motors and other equipment shall be optimized**
- **2.1 lb/KW-hr (gross output, 12-month rolling)**
- **6,024,107 TPY (12-month rolling)**
- **Based on CEM and emission factors from 40CFR98, Table 1 for non-CO<sub>2</sub> emissions**

# Questions

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