



# Greenhouse Gas Mitigation Options Database and Tool -

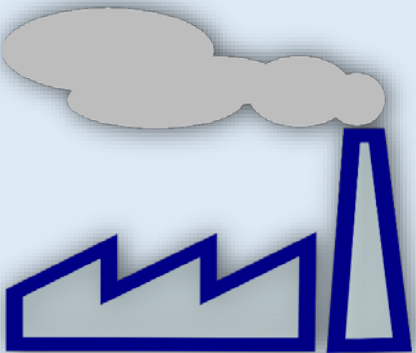
## Data repository of GHG mitigation technologies

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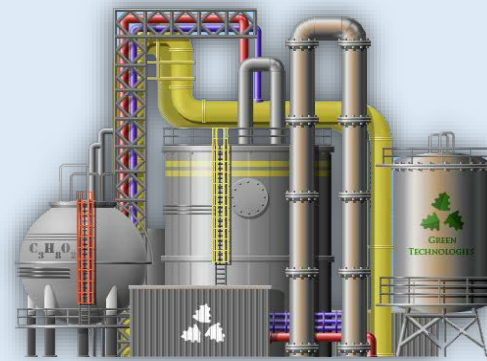
Power Sector



Cement Sector



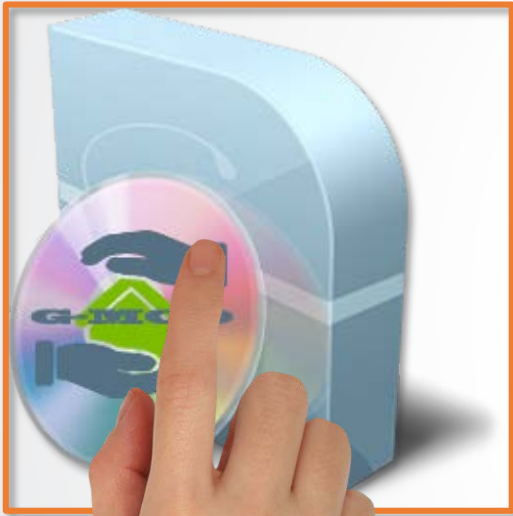
Pulp & Paper Sector



Refinery Sector



Landfill Sector



- 
- GMOD Production



- 
- GMOD Framework  
(Database & Tool)



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- GMOD Usability, and  
Credibility
  - Future Work



# Foreword

- Object of this presentation
  - We are presenting a mitigation options database and tool (GMODT). It is a comprehensive information source on GHG control options and the tool provides decision makers with the capability to develop a host of alternative scenarios by constructing a conceptual-based source with suitable alternative control technologies. Examples are demonstrated in the context of normalizing technologies for achieving a most reliable and cost effective mitigation options target.
- Intended audience
  - The material presented here is intended to be of interest to decision makers and modelers. technology developers, investors and state level agencies (permitting activities) who develop & evaluate mitigation options for the future use.
- Disclaimer
  - Examples results are provided for the illustrative purpose only. The data collection and refinement is in-process, future data and results may change. While this presentation has been reviewed and cleared for the ACLCA Conference by the U.S. Environmental Protection Agency, the view expressed here are those of the authors and do not necessarily represent the official views or policies of the Agency.



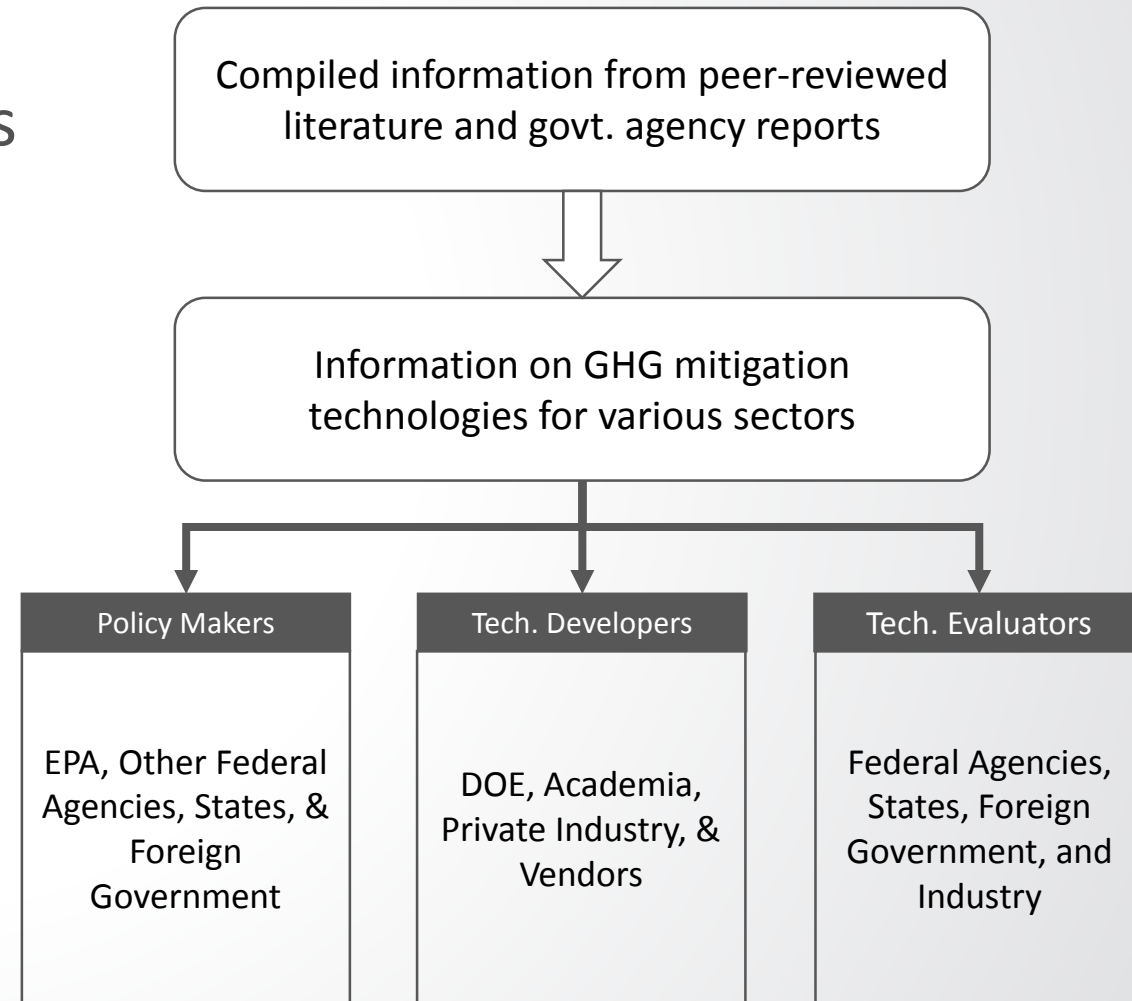
# What is GMOD Database and Tool?

- Data repository of greenhouse gas (GHG) mitigation technologies for the Power, Refineries, Pulp & Paper, Cement and Landfill sectors
  - Secondary data collected from publically available sources
  - Provides cost, emissions, performance and availability
  - Includes default data and parameters defined for capital costs, lifetime economic and utilization rates
  - More than 400 data sources



# GMOD Support for Decision-making

- Serves as a **comprehensive source** for GHG control options for various sectors
- Designed to answer the following questions (but not limited to):
  - What is the best available technology for the situation?
  - What is the technology stage of development and availability?
  - What is the projected utilization cost?
  - What are the ancillary impacts of technology deployment?
  - What are the emission reduction costs?







# GMOD Requirements & Availability

- An executable package that can operate on Microsoft and OS X operating systems:
  - Operating system: Microsoft windows 7, 8, 8.1, 10 or OS X 10.x,
  - Memory (RAM): 256 MB or higher
  - Processor: 800 MHz or higher
  - Hard drive space: 500 MB or higher, and
  - An internet connection is recommended
- It is anticipated that it will be available by Aug. 2017 on the EPA website ([www.epa.gov/gmod](http://www.epa.gov/gmod) - under construction)
- Terms of Use

*"The user is responsible for understanding the implications of changing any variable default values. EPA is not responsible for erroneous output due to unrealistic changes the user makes to the default values in the program."*





- 
- GMOD Introduction



- 
- GMOD Usability, and Credibility



- 
- Future Work



# GMOD Database & Tool Structure

Tool for Mitigation Options

File Default Database Paint Style Tools Help

Logout Add User DLink

Flows Units Materials CAUL CEPCI Controls Sectors Filtration

**Greenhouse Gas Mitigation Options Database and Tool (GMODT)**

Default flow/emissions parameters, fuel and material types, economic and engineering parameters and controls

GMOD datasets and data filtration options

*Greenhouse Gas Mitigation Options Database (GMOD)*

**Greenhouse Gas Mitigation Options Database (GMOD)**  
A comprehensive greenhouse gases (GHGs) mitigation options database that is compiled based on information from industry, government research agencies, and academia. The database can also be used to assess the performance, costs, and limitations of various mitigation control options.

VERSION: Vol: 2.0.0.1 | Comments | USER: Technician (Technician) | DATE: 1/29/2015





# GMOD Tool (Interface) Structure

- Default Data:
  - Flows/Emissions
  - Standard Units
  - Material/Fuel Types
  - Sources type & sub-type
  - Chemical Engineering Cost Index Data
  - Mitigation Options

The screenshot displays the 'Tool for Mitigation Options' interface, which is the central hub for the Greenhouse Gas Mitigation Options Database and Tool (GMODT). The main window features a menu bar (File, Default, Database, Paint Style, Tools, Help) and a toolbar with icons for Logout, Add User, DLink, Flows, Units, Materials, CAUL, CEPCI, Controls, Sectors, and Filtration. Below the toolbar, the title 'Greenhouse Gas Mitigation Options Database and Tool (GMODT)' is prominently displayed.

Arrows from the 'Default Data' list point to specific components of the interface:

- Flows/Emissions:** Points to the 'Flows' button in the toolbar.
- Standard Units:** Points to the 'Units' button in the toolbar.
- Material/Fuel Types:** Points to the 'Materials' button in the toolbar.
- Sources type & sub-type:** Points to the 'CAUL' button in the toolbar.
- Chemical Engineering Cost Index Data:** Points to the 'CEPCI' button in the toolbar.
- Mitigation Options:** Points to the 'Controls' button in the toolbar.

Other visible windows include:

- Units: Unit of Mass:** A window showing a list of units (kg, g, long ton, mg, oz, short ton, t) and their conversion factors.
- CEPCI Entry:** A window for entering the Engineering Cost Index, including fields for Reference Year, Index Value, and By.
- Sectors:** A window showing a list of sectors (Pulp & Paper Sector, Cement Sector) and their associated source types and sub-types.
- Control List:** A window showing a list of control technologies (e.g., CO2 Removal, Biomass, NGCC, IGCC) and their associated reduction technologies.



# GMOD Interface – Technologies Data

- Technologies data:
  - Sectors data
  - Data filtration options

Tool for Mitigation Options

File Default Database Paint Style Tools Help

Logout Add User DLink Flows Units Materials CAUL CEPCI Controls Sectors Filtration

## Greenhouse Gas Mitigation Options Database and Tool (GMODT)

Sectors

Power

Mitigation Technology Description

Source Type	Status	Stage Of Development	Ref. Year	Capacity	By	Date
...						

Technology: New 379 MW PC Boiler (Super) w/ Post Comb-Econ FG Plus, 90% CO2 Removal

File Tools Help

New Open Save Save As... Reload General Info. LCI Results Report Help

Technology: New 379 MW PC Boiler (Super) w/ Post Comb-Econ FG Plus, 90% CO2 Removal

Description: Retrofitted with Econamine Flue Gas (FG) Plus Carbon Capture and Storage (CCS) at 90% CO2 Removal - low output.

Availability Year: 2015 By: EPA

Base Year: 2007 Date: 7/1/2011

DataSet Type: Undefined

Summary Costs and Others Emissions Resources Documentation

General Summary

Facility Status: New Facility Type: New W/Controls Net Output [MW]: 379.00 Net HR Before, [mmBtu/MWh]: 0

Stage of Development: Demonstration Aux. Power [kWh/MWh]: 232.98 Net HR After, [mmBtu/MWh]: 12.66

Technology Location: Greenfield, Midwestern US (Generic site) Technology Vendor: Fluor

Reduction Technology

Source Type: Coal Boiler Source Sub-Type: Supercritical Economic Life [yrs]: 40.00 Capacity Factor [%]: 0.80

Reduction Tech. 1: Sub-reduction Tech.: Sub2-reduction Tech.: MEA

Reduction Tech. 2: Sub-reduction. Tech2: Sub2-reduction. Tech2: Select...

VERSION: Vol: 2.0.0.1 Comments

RESET FILTER

COMPARE SELECTION GENERATE AVE.

US Emissions (Technology) DATE: 7/2/2012

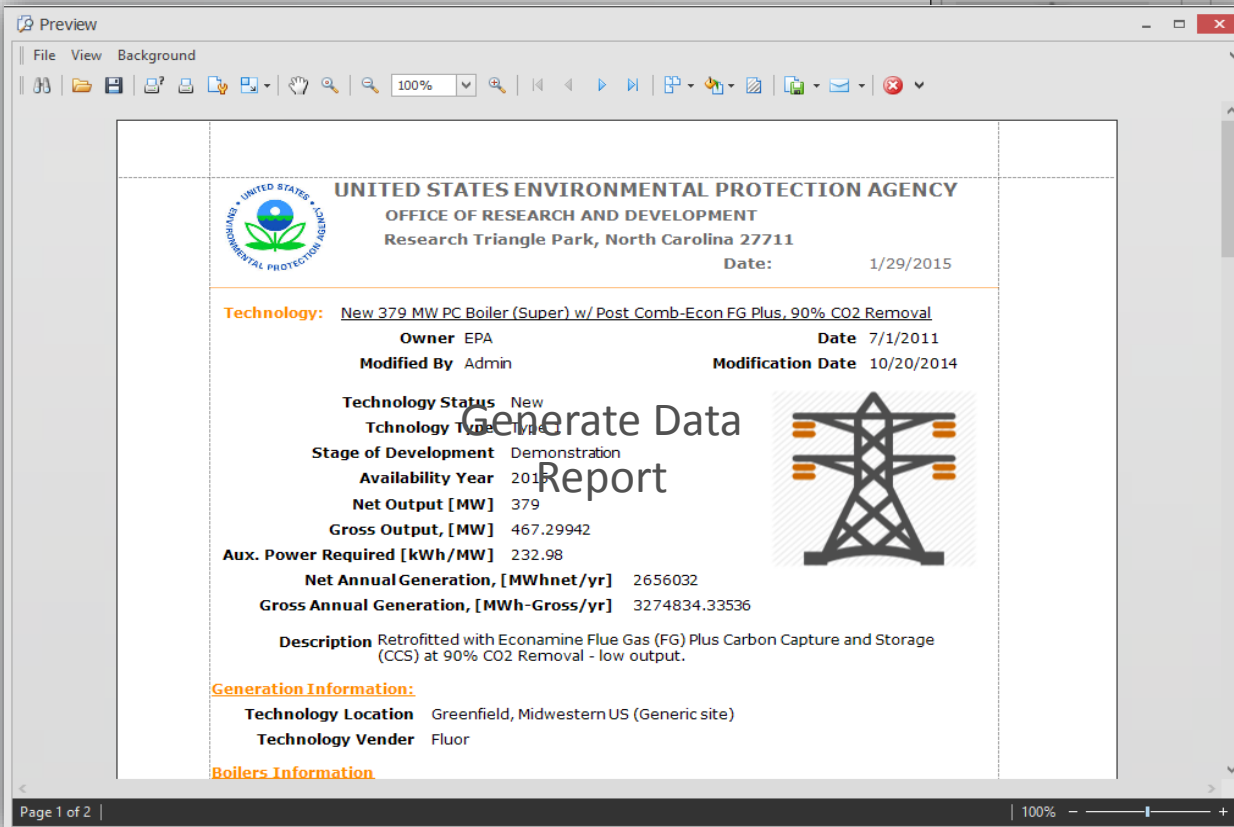
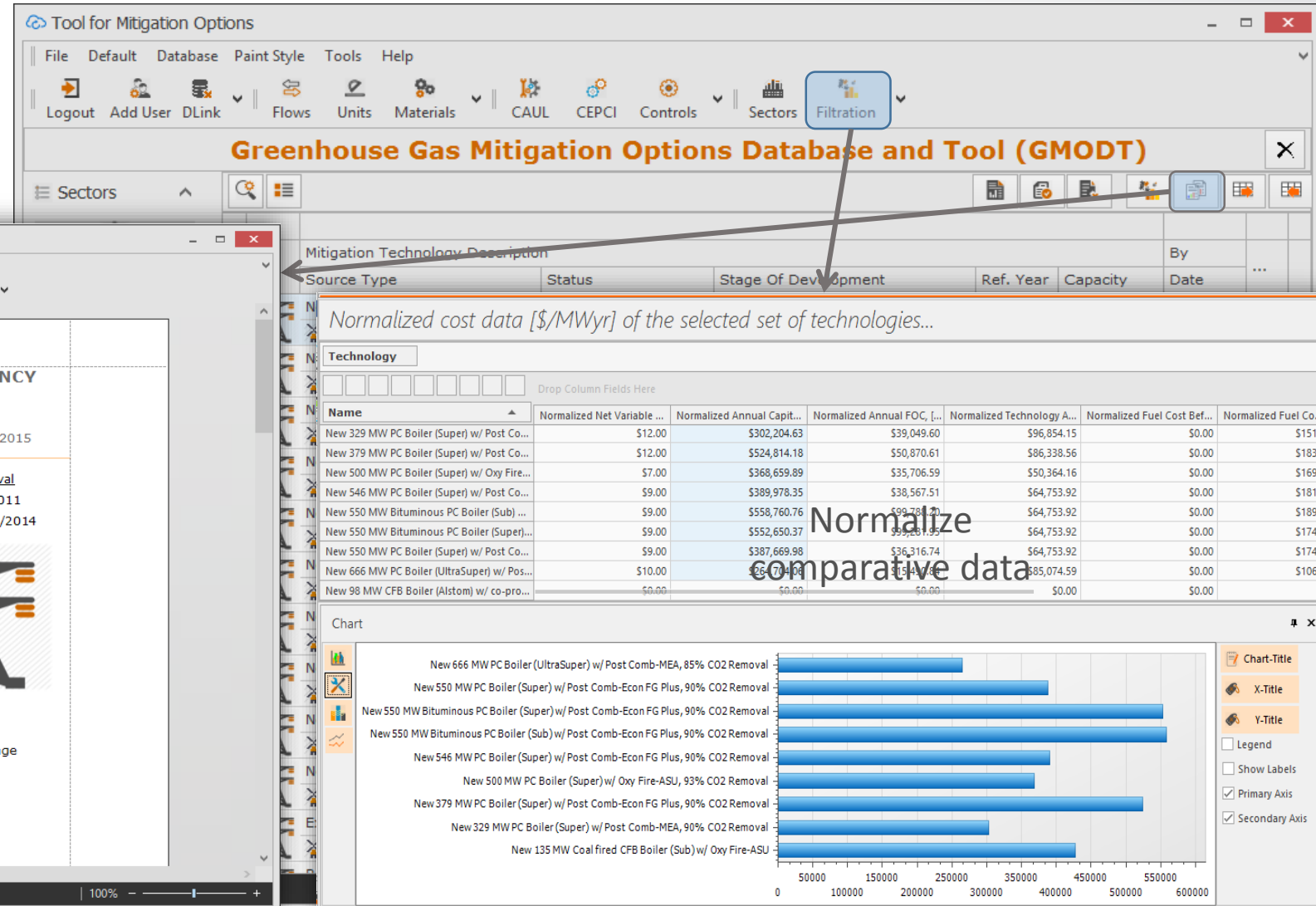
Technologies				Mitigation Options	
Name	Source Type	Red. Technology	Reference	Red. Tchn. 1A	Reference
Status	Development Stage	Capacity [MWh]	Sub-source Type		
New 379 MW PC Boiler (Super) w/ Post Comb-Econ FG Plus, 90% CO2 Re...	Coal Boiler	CO2 Removal	Ref. 1: US Department of E...	CO2 Removal	Ref. 1: US Department of E...
New 550 MW PC Boiler (Super) w/o CCS	Coal Boiler	No control	Ref. 1: US Department of E...	No control	Ref. 1: US Department of E...
New 546 MW PC Boiler (Super) w/ Post Comb-Econ FG Plus, 90% CO2 Re...	Coal Boiler	CO2 Removal	Ref. 1: US Department of E...	CO2 Removal	Ref. 1: US Department of E...
New 193 MW Coal fired CFB Boiler (Sub) w/o CCS	Coal Boiler	No control	Ref. 1: US Department of E...	No control	Ref. 1: US Department of E...
New 135 MW Coal fired CFB Boiler (Sub) w/ Oxy Fire-ASU	Coal Boiler	OxyFire	Ref. 1: US Department of E...	OxyFire	Ref. 1: US Department of E...
New 135 MW Coal fired CFB Boiler (Sub) w/ Oxy Fire-ASU	Coal Boiler	OxyFire	Ref. 1: US Department of E...	OxyFire	Ref. 1: US Department of E...
New 132 MW Coal fired other boiler; atmospheric pressure CMB w/ Oxy Fir...	Coal Boiler	CO2 Removal	Ref. 1: US Department of E...	CO2 Removal	Ref. 1: US Department of E...
New 161 MW Coal fired other boiler; atmospheric pressure CMB w/ Post C...	Coal Boiler	CO2 Removal	Ref. 1: US Department of E...	CO2 Removal	Ref. 1: US Department of E...
New 197 MW Coal fired other boiler (Sub); w/ Oxy Fire-Membrane	Coal Boiler	CO2 Removal	Ref. 1: US Department of E...	CO2 Removal	Ref. 1: US Department of E...
New 164 MW Coal fired CFB Boiler (Indirect) w/ Chem Loop	Coal Boiler	CO2 Removal	Ref. 1: US Department of E...	CO2 Removal	Ref. 1: US Department of E...
New 164 MW Coal fired CFB Boiler (Indirect) w/ Chem Loop	Chemical Looping	Inherent Separation	Ref. 1: US Department of E...	Inherent Separation	Ref. 1: US Department of E...

Data filtration options ...



# GMOD Interface – Outputs

- GMOD Outputs:
  - Data report
  - Analysis output





- GMOD Introduction



- GMOD Framework  
(Database & Tool)



- GMOD Applications, and  
Credit
- Future



## Brief Example A: Existing Power Unit

- An existing electric power is seeking to **upgrade a pulverized** coal boiler by improving its energy efficiency
- Assumptions:
  - Boiler capacity: **315 MW**
  - Financial constraint of upgrade: **\$1,905/MW**
  - GHG and air pollutant emissions must meet specific
  - Any option must be commercially available
  - Others: economic life - **30yrs**, utilization - **75%**
- **Question:** What does GMOD suggest for the best control option to meet emission reduction standards?



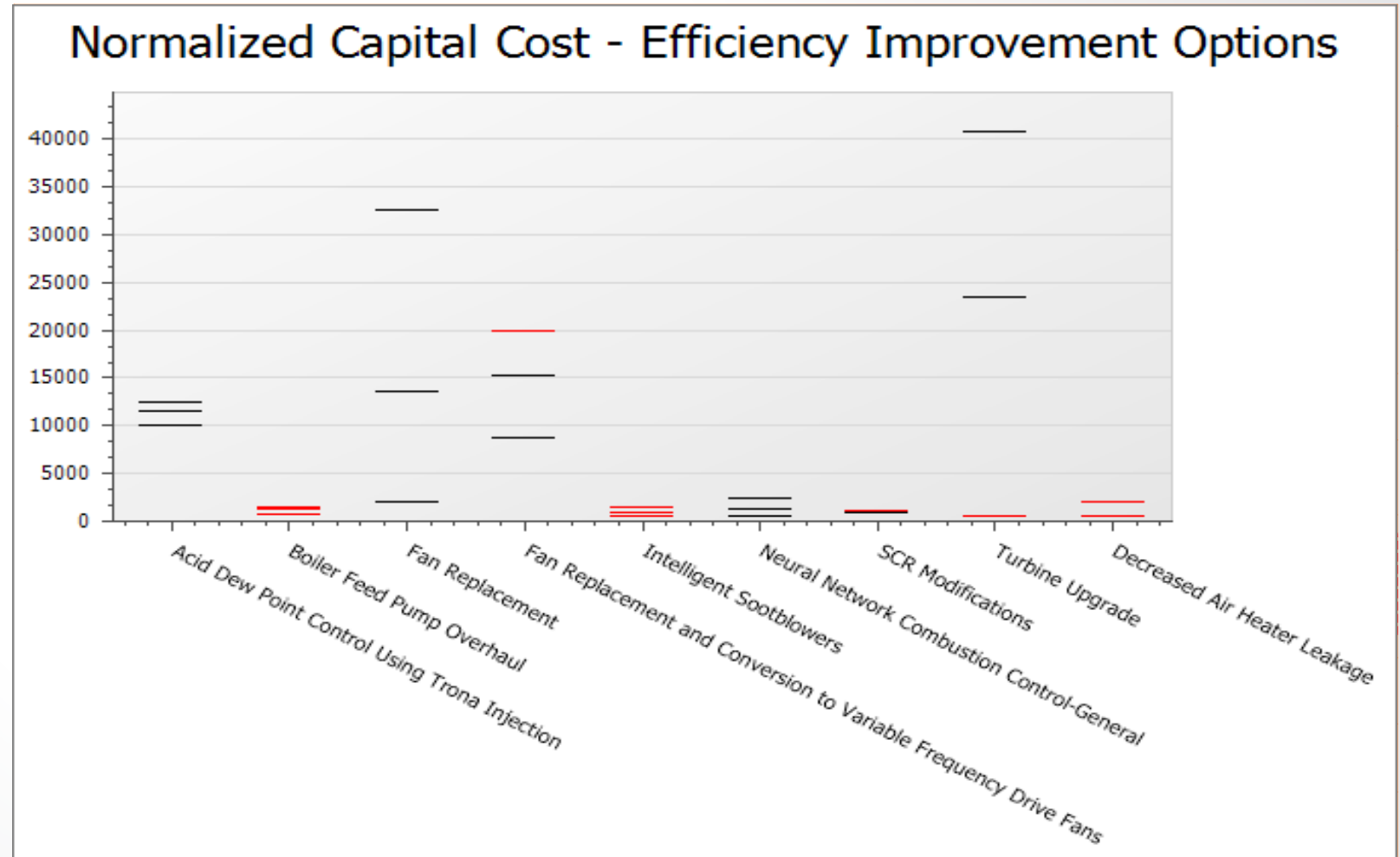


# Brief Example: Existing Power Unit (cont'd)

## GMOD

### Recommendations

- Installing intelligent **soot blowers** for CO<sub>2</sub> reduction
- **Boiler condenser cleaning** that provides emission reductions with no capital expenditure





## Example B: A New Power Unit Construction

- An electric utility would like to construct a new power production unit:
- Technology/geographical constraints
  - Due to the geographical limitations, the wind turbine, geothermal, and solar options are not viable
  - and does not wish to build a nuclear plant in light of site selection difficulties
  - Coal-fired supercritical pulverized coal **(PC) boiler**, unit net capacity of at **least 550 MW**, utilization rate of **80%** and economic life - **40 years**
  - Demonstration level options only
- **Question:** How GMOD can help the technology developer to select most mitigative and compatible options to control emissions from PC-boiler to meet emission reduction standard?



## Example B: A New Power Unit Construction

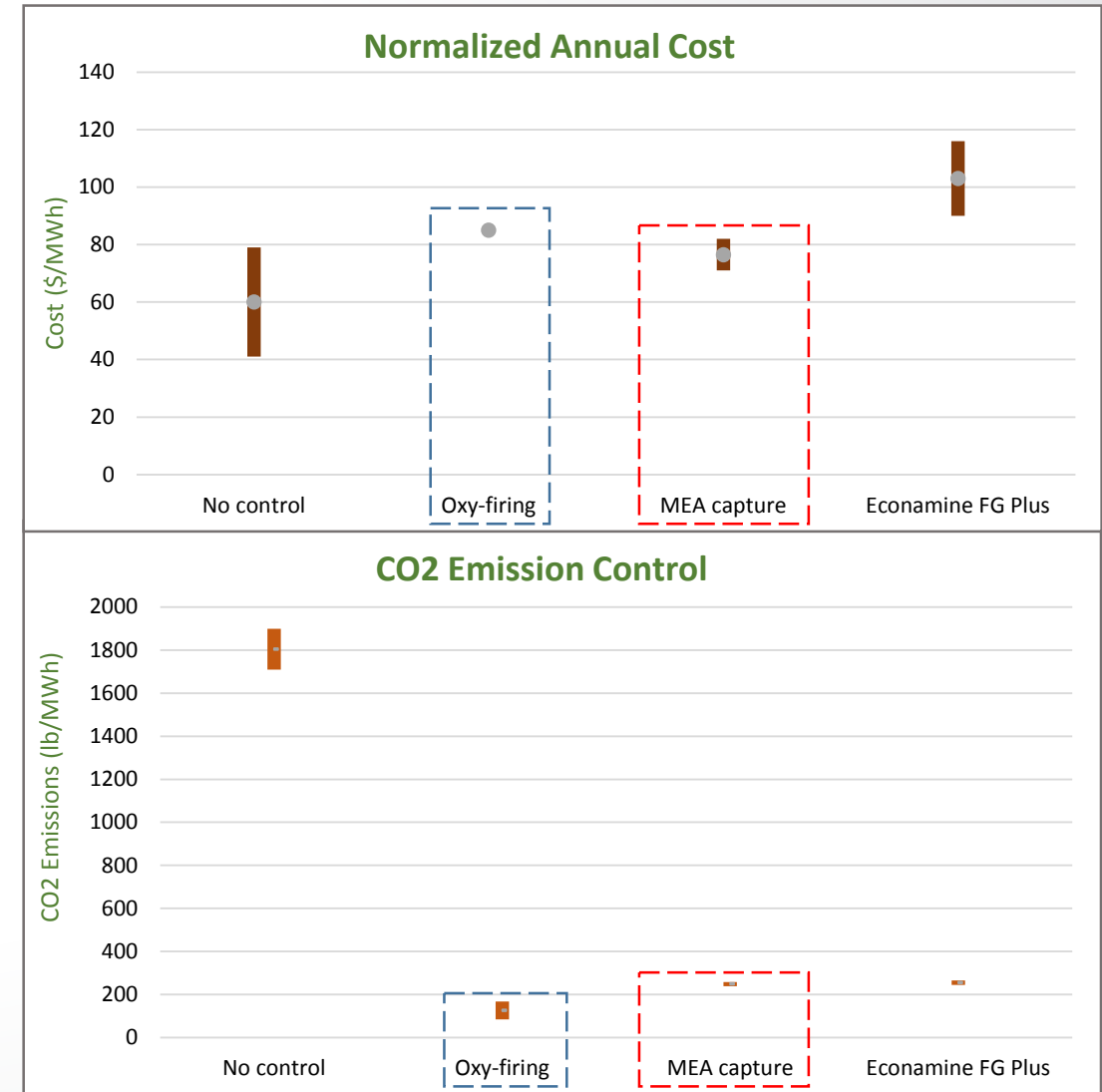
- Selected demonstration level mitigation options for the technology of interest:
  - No GHG Control
  - Oxy-firing and an air separation unit plus carbon capture and storage (cryogenic distillation for 95% oxygen purity; energy requirements supplied by the PC boiler and subtracted from the gross output)
  - Post-combustion using MEA2 carbon capture and storage
  - Post-combustion with Econamine FG Plus carbon capture and storage
  - Post-combustion chilled NH3 carbon capture and storage
  - Post-combustion dry carbonate carbon capture and storage

} Eliminate –  
Pilot Scale



## Example B: A New Power Unit Construction

- GMOD emissions reduction and cost recommendations:
  - Oxy-firing has the lowest CO<sub>2</sub> emission rate (approx. 170 lbs./MWh)
  - Post-combustion MEA is the most cost-effective (total generation costs approx. \$77/MWh).
  - CO<sub>2</sub> emission rates for post-combustion MEA and post-combustion Econamine FG Plus are closer but total generation cost of the Econamine FG Plus is higher.





# GMOD Summary and Status

- Current version of database contains approximately 400 datasets for power, refinery, cement, pulp and paper, and landfill sectors
- User friendly interface allows users to:
  - Project best mitigation technologies, and
  - Compare similar technologies
- Database Sector Status:
  - Power, Cement and Pulp and Paper sectors are under revision and will be publically available in FY2017\*
  - Refinery and landfill sectors are under development and will be available by end of FY2018\*, Iron & steel sectors expected by end of FY2019\*.

\* Depends on sources availability.





# Thank You!

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