Greenidge Multi-Pollutant Control Project

Benefits Presentation

Power Plant Improvement Initiative

Cost-Effective Multi-Pollutant Control for Smaller Coal-Fired Power Plants

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Outline

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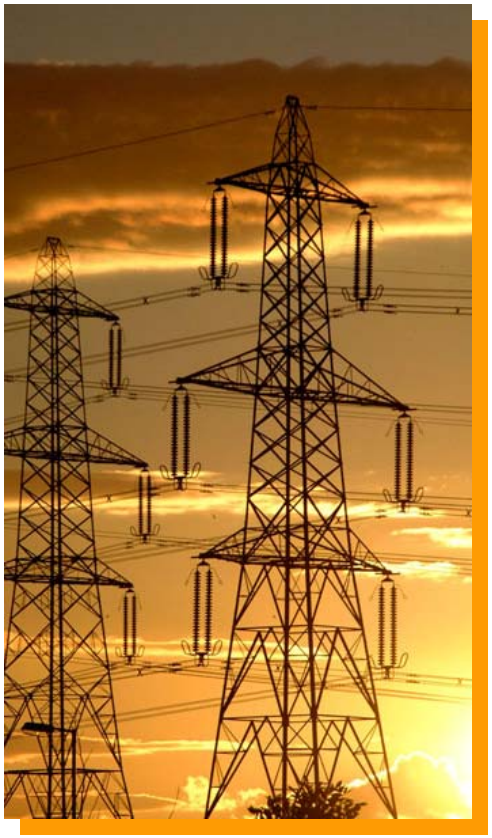

Outline (continued)

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Executive Summary

- **CONSOL Energy Inc. and AES Greenidge will design, construct and operate a cost-effective multi-pollutant control technology applicable to approximately 440 of Nation's smaller coal fired power plants, ranging in size from 50 to 300 MWe**
  - Hybrid control system includes selective non-catalytic reduction (SNCR)/in-duct selective catalytic reduction (SCR) for NO_X control
  - CFBDS system with activated carbon injection and recycled baghouse ash controls SO_2, mercury (Hg), and acid gas (SO_3, HCl, HF) emissions
- **Goal is to demonstrate significant improvements in control of NO_X, SO_2, Hg, acid gases, and fine particulate emissions**

Executive Summary (continued)

- **107 MWe demonstration at AES Greenidge Unit 4, near Dresden, NY**
- **Successful commercial application of multi-pollutant control technology in U.S. would significantly reduce emissions**
  - 29,200 tons/year of NO_X
  - 683,000 tons/year of SO_2
  - 1.5 tons/year of Hg
  - 18,800 tons/year of acid gases
- **Up to $7.2 billion would be saved by deferring 6 GWe plant replacement**

Project Information
Plant, Fuel, Location, Cost, and Schedule

- **107 MWe coal-fired power plant demonstration of a cost-effective multi-pollutant control technology for smaller coal-fired power plants, ranging in size from 50 to 300 MWe**
- **Fuel: Eastern U. S. bituminous coal (>2% sulfur) with biomass co-firing**
- **Location: Dresden, NY**
- **Project cost: $32.7 million;**
  DOE share $14.3 million
  AES Greenidge share $18.4 million
- **Schedule**
  - 2004 Start
  - 2006 Construction
  - 2007 to 2008 Operation
  - 2008 Completion

Project Information (continued)
Team Members

- **CONSOL Energy Inc. (Pittsburgh, PA)**
  - Prime contractor
  - Project administration, performance testing, and reporting
- **AES Greenidge, LLC (Dresden, NY)**
  - Host, operating multi-pollutant control facility
  - Subcontractor to CONSOL
- **Babcock Power Environmental Inc. (Worcester, MA)**
  - Engineering, procurement and construction contractor
  - Subcontractor to AES Greenidge

Project Information (continued)
Technology Summary

- **Project will demonstrate a cost-effective SNCR/single bed, in-duct SCR system in combination with a circulating fluidized bed dry scrubber system to reduce**
  - NO_x
  - SO_2
  - Hg
  - Acid gases
  - Particulate matter (PM)

Project Information (continued)

NO_X Control - SNCR/SCR Process

- **Complementing low-NO_X burners, urea-based SNCR is strategically located upstream of a single-bed in-duct SCR**
  - Stand-alone SNCR's normally operate at higher temperatures
    - Protects against ammonia slip
    - Does not utilize urea reagent as effectively
  - Single-bed SCR allows SNCR to operate at lower temperatures
    - Enhances urea utilization
    - Improves NO_X reduction performance
    - SNCR supplies all ammonia required by SCR

Project Information (continued)
NO_X Control - SNCR/SCR Process

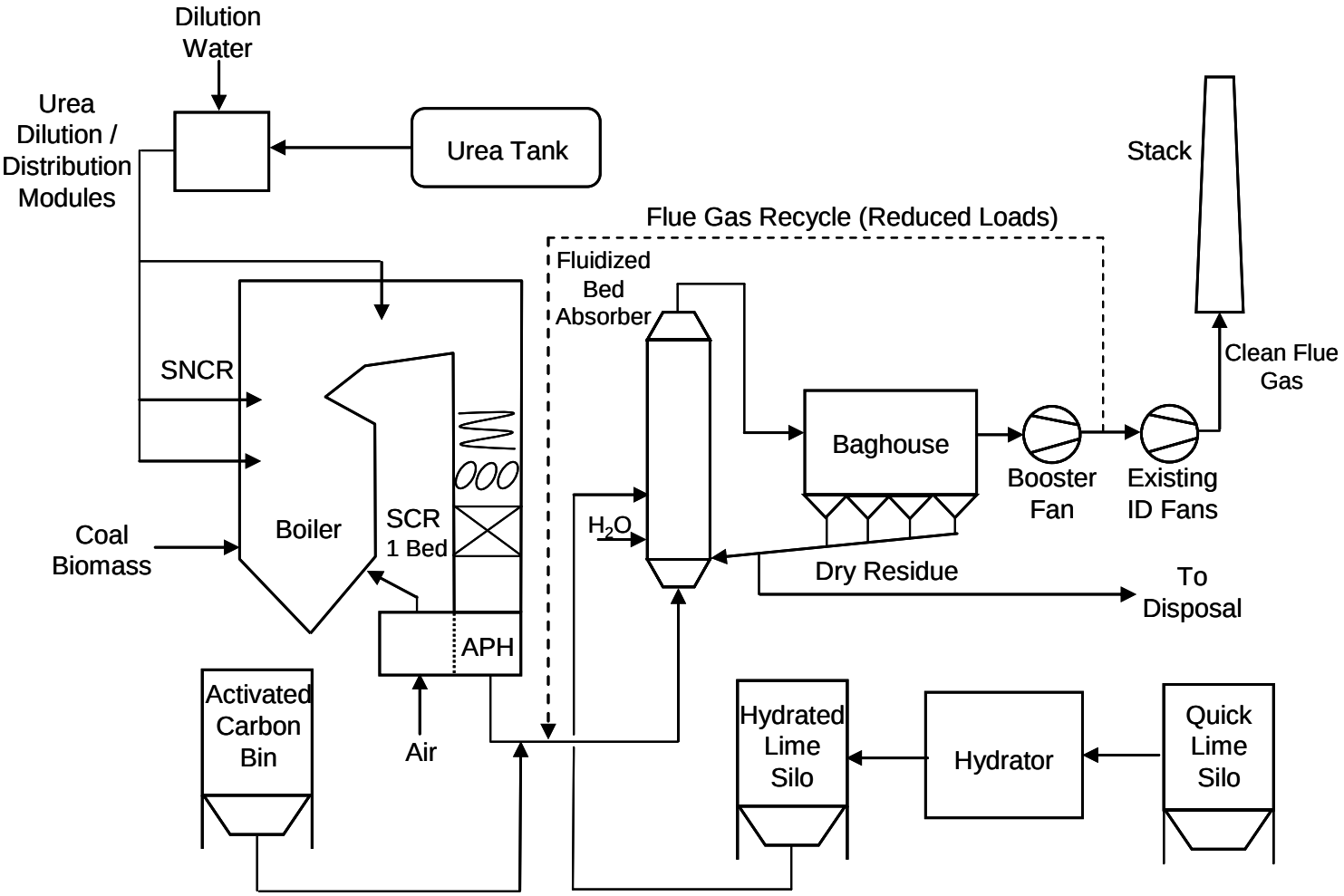
- **Proprietary Delta Wing™ static mixing technology provides advantages to in-duct SCR operation**
  - Resulting homogeneous flue-gas at SCR inlet ensures performance of single layer catalyst
  - Optimal flue-gas and NH_3 mixing
    - Minimizes NH_3 slip
    - Maximizes NO_X removal efficiency
  - Reduced load operation does not affect homogeneous mixing capability
  - Technology maintains ash entrainment and distribution, which reduces potential for SCR catalyst fouling and erosion

Project Information (continued)
Circulating Fluidized Bed Dry Scrubber (CFBDS)

- **The CFBDS system uses a fluidized bed absorber to facilitate flue-gas contact with injected hydrated lime and activated carbon**
  - More contact time between flue gas and activated carbon and hydrated lime
  - Activated carbon adsorbs Hg
  - Lime reacts with SO_2 and SO_3, HCl, and HF gases to form benign solids, which are captured in baghouse
  - Lime and activated carbon sorbents captured in the baghouse are recycled to the CFBDS to enhance utilization
  - Separate injection of water and hydrated lime enables desired emission reduction without limitations of flue gas moisture and temperature

Project Information (continued)

Greenidge Multi-Pollutant Control Schematic

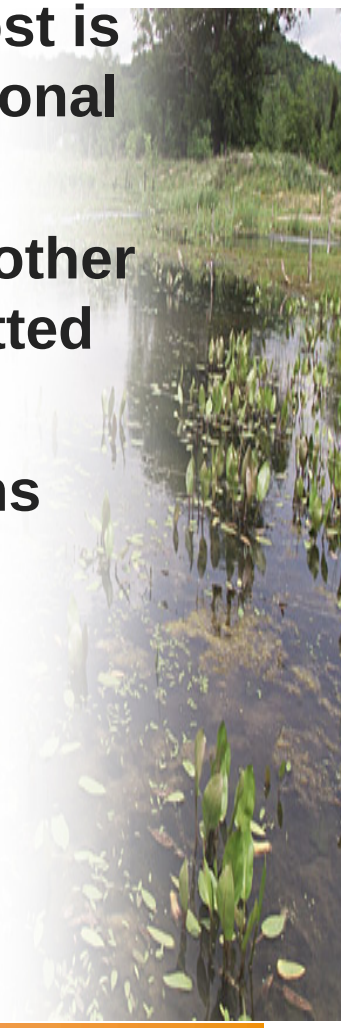


Project Information (continued)
Unique Contribution

- **Designed to retrofit smaller coal-fired plants (50 to 300 MWe) representing 19% of total U.S. coal-fired generating capacity (60 GWe)**
  - Extends life of smaller plants, avoiding early retirement due to more stringent environmental regulations
  - Retrofits are less expensive than new plant construction
- **Project demonstrates low-cost multi-pollutant controls once thought cost-effective for only larger generating facilities**
- **Greenidge NO_X control technology is estimated to require about 65% capital cost and 75% levelized annual cost of a conventional SCR when installed on a 100 MWe unit**

Project Information (continued)
Unique Contribution

- **Circulating fluidized bed dry scrubber capital cost is estimated to be 40% less than that of a conventional wet scrubber when installed on a 100 MWe unit**
- **In addition to removing SO_2, scrubber removes other acid gases that can form secondary $PM_{2.5}$ if emitted to atmosphere**
- **Biomass co-firing may improve overall emissions performance through**
  - Reduced fuel-bound nitrogen and sulfur levels
  - Increased volatile matter content
  - General combustion characteristics



Estimated Benefits
Approach

- **Estimate available market**
- **Estimate market penetration**
- **Quantify differences between conventional power plants with and without the hybrid SNCR/SCR and CFBDS technologies being demonstrated (pollutant emissions, tons/year)**

Estimated Benefits
Emissions Reduction Estimation Methodology

- **Quantify AES Greenidge Unit 4 2003 emissions**
  - SO_2 emissions data from NETL Coal Power Database
  - NO_X emissions data from plant monitoring results
    - Emissions rate varies with station electrical load
    - Representative station electrical load profile used for emissions determination
  - Acid gas emissions from EPA's Toxic Release Inventory (TRI)
    - Overall plant data parsed by unit based on SO_2 emissions
  - Hg emissions estimated with heat input data and design basis fuel

Estimated Benefits
Emissions Reduction Estimation Methodology

- **Estimate Unit 4 emissions with multi-pollutant control technology, assuming Greenidge multi-pollutant control removes**
  - 95% of SO_2
  - 95% of acid gases
  - NO_X to 0.10 lb/10^6 Btu at high load
    - Estimated NO_X emissions reduction based only on project scope modifications
    - Representative station electrical load profile used for emissions determination
  - 90% of Hg
- **Emissions reduction estimation based on difference between Unit 4 2003 quantified emissions and Unit 4 emissions with multi-pollutant control**

Estimated Benefits (continued)
Market Penetration Assumptions

- **Economics for this technology are based on number of smaller coal-fired generators requiring multi-pollutant controls**
  - Assume same (on average) baseline emissions, capacity factor; etc., as AES Greenidge unit 4
- **Assume that Greenidge penetrates 10% of small generator market and reconfigures plants in lieu of retirement**

Estimated Benefits (continued)

Market Penetration

- **Estimated market for multi-pollutant control technology constitutes 60 GWe* of available U.S. generating capacity in 50 to 300 MWe range**
- **National benefits estimates are based on capturing 6 GWe of this market (10%)**

* Source: NETL Coal Power Data Base

Estimated Benefits (continued)

Greenidge Plant: Emissions Removed[1]

Pollutant	Tons[2]/year
NO_X	500
SO_2	12,000
Hg	50 lbs
Acid Gases	300

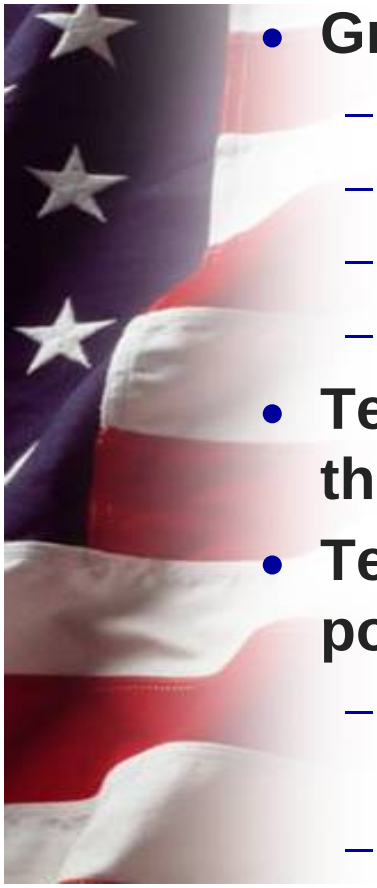
[1] Unless otherwise noted

[2] Based on emissions reduction estimation methodology (pages 16,17)

Estimated Benefits (continued)
Regional

- **Reduced local air emissions**
- **AES Greenidge Unit 4 generating plant will remain operational by complying with emissions requirements, avoiding earlier retirement**

Estimated Benefits (continued)
National



- **Greenidge multi-pollutant control removes**
  - 95% of SO_2
  - 95% of acid gases
  - NO_X to 0.10 lb/10^6 Btu at high load
  - 90% of Hg
- **Technology supports biomass co-firing (up to 10% thermal input)**
- **Technology can be retrofitted to existing coal-fired power plants or integrated into future plant designs**
  - Relatively low capital cost ($330-340/kW), including combustion modifications (for a 110 MWe unit)
  - Small space requirement of < 0.5 acre (110 MWe unit)

Estimated Benefits (continued)
National

- **Uses Nation's abundant coal resources thereby increasing energy independence and security**
- **Furthers environmental objectives for America by providing effective, lower-cost environmental compliance capability for existing generation fleet in 50 to 300 MWe range**

Estimated Benefits (continued)
Pollutant Reductions from Commercialization

Pollutant	Emission Reduction[1,2] tons/year	Current emissions from all coal-fired boilers in the United States[3], tons/year
NO_X	29,200	3,856,988
SO_2	683,000	10,149,019
Hg	1.5	49.2
Acid Gases	18,800	283,797

[1] Based on emissions reduction estimation methodology (pages 16,17)

[2] Basis: 6 GWe market penetration

[3] Source: NETL Coal Power Data Base

Conclusions

- **Greenidge's innovative multi-pollutant control technology for coal-fired power plants in the 50 to 300 MWe range will**
  - Enable these plants to operate in compliance with environmental regulations
  - Provide a cost-effective option for multi-pollutant control technology

Visit the NETL web site for information on all Power Plant Improvement Initiative and Clean Coal Power Initiative projects

www.netl.doe.gov/technologies/coalpower/cctc