

EnPRO 356 Spring 2005

Mercury Pollution Prevention Technologies

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Overview

- Problem & Solution
- Regulations
- Virtual Sorbent Bed
- Competitors
- Market Size & Strategy
- Financials
- Risks & Assumptions
- Path Forward

Problem

- Mercury is a persistent, bio-accumulative nerve toxin.
 - In high doses, mercury kills.
- **Four (4) tablespoons** of mercury distributed among the entire population of Canada (32 million) would result in toxic levels of mercury.
- Coal Plants are releasing **48 Tons** of mercury every year in the United States alone
- U.S. EPA states that a safe dosage is:
0.1 µg/kg body weight/day

Solution

- The United States has announced new regulation
 - Released March 15th, 2005
- These regulations require a reduction in coal-fired power plant emissions
- Advanced technology will be used to achieve emission reduction

Regulations



Regulations - The Clean Air Mercury Rule (CAMR)

- 1st phase cap of **38 tons per year** in 2010
 - **21% decrease** in emissions
- 2nd phase cap of **15 tons per year** in 2018
 - **69% decrease** in emissions
- CAMR applies to a wide range of generating units
- No provisions for “**grandfathering**” for age

Regulations - The Clean Air Mercury Rule (CAMR)

- Cap-and-trade system for reducing emissions
- Emissions limits (per generating unit):
 - Bittuminous coal: 21×10^{-6} lb/MW·h
 - Subbituminous coal
 - Wet FGD: 42×10^{-6} lb/MW·h
 - Dry FGD: 78×10^{-6} lb/MW·h
 - Lignite coal: 145×10^{-6} lb/MW·h

The Opportunity

- EPA only defined emissions limits and not the technology
- Any technology that can meet the regulations effectively is needed
- The VSB shows promise as a leading candidate

Virtual Sorbent Bed



Virtual Sorbent Bed (VSB) Background

- The VSB is a new technology designed to **capture mercury** in power plants
- Works as an addition to an existing technology, the Electrostatic Precipitator (ESP)
- Currently, **70%** of all power plants already have ESP's installed in them.

Side View of ESP

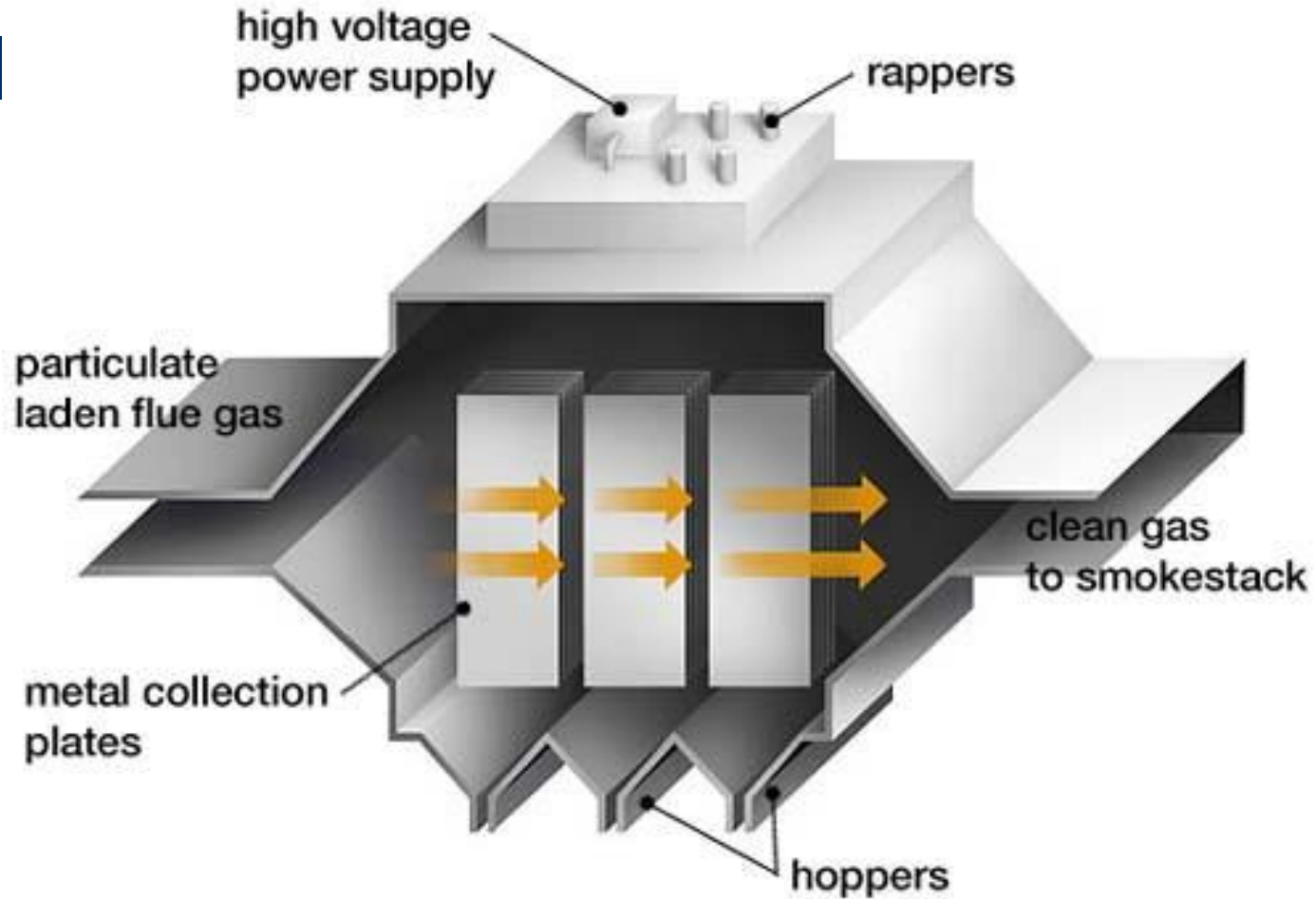
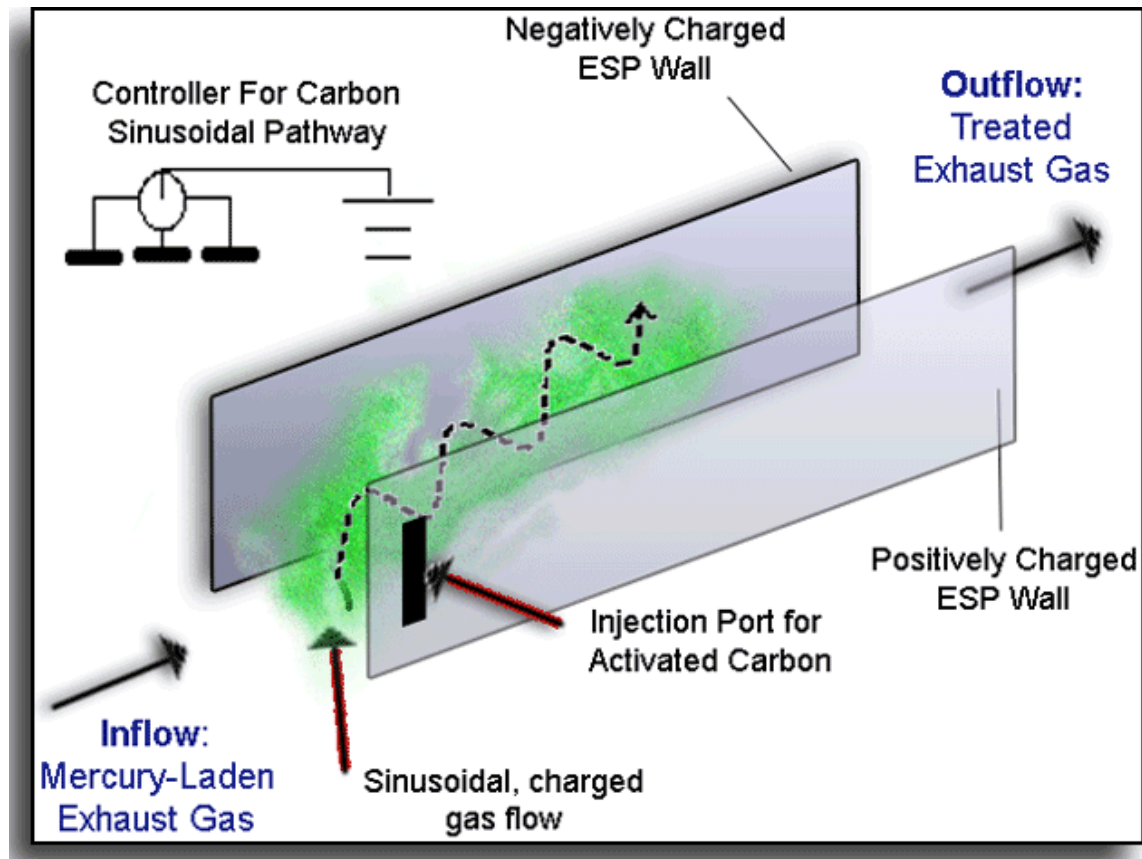


Diagram of How the VSB Works



Advantages

- Cost: modifying existing ESP's should be **cheaper** than adding entirely new equipment
- Efficiency: activated carbon based technologies are the **most efficient** technologies currently practiced.
- Compatibility: expected to **work well** with most power plants on the market.
- Size: small size makes it **easier to install**, space constraints less of an issue
- Cross-flow pathway of the activated carbon results in **greater contact** with the Hg-contaminated gas

Competitors

The image features a solid green background. On the left side, there is a white rounded rectangle that extends horizontally across the middle of the frame. The word "Competitors" is written in a bold, dark blue font within this white area. Below the white rectangle, a thick, dark blue horizontal bar spans across the lower portion of the image.

Top Competitors

Technology type	Efficiency
FGD+C-ESP	80
FF+ESP	90
Fabric Filter (FF)	70
Spray Dryers Absorbers (SDA) +FF	98
Electro-Catalytic Oxidation (ECO) Powerspan	80+
MerCap™	95

Table of Advantages/Disadvantages

Technology type	Cost	Ease of Implementation	Retrofittable	Proven
VSB	✓	✓	✓	X
FGD+C-ESP	~	X	✓	✓
FF+ESP	X	X	~	✓
Fabric Filter (FF)	~	✓	X	✓
Spray Dryers Absorbers (SDA) +FF	X	~	X	✓
Electro-Catalytic Oxidation (ECO)	DNK	DNK	X	X
MerCap™	DNK	DNK	✓	X

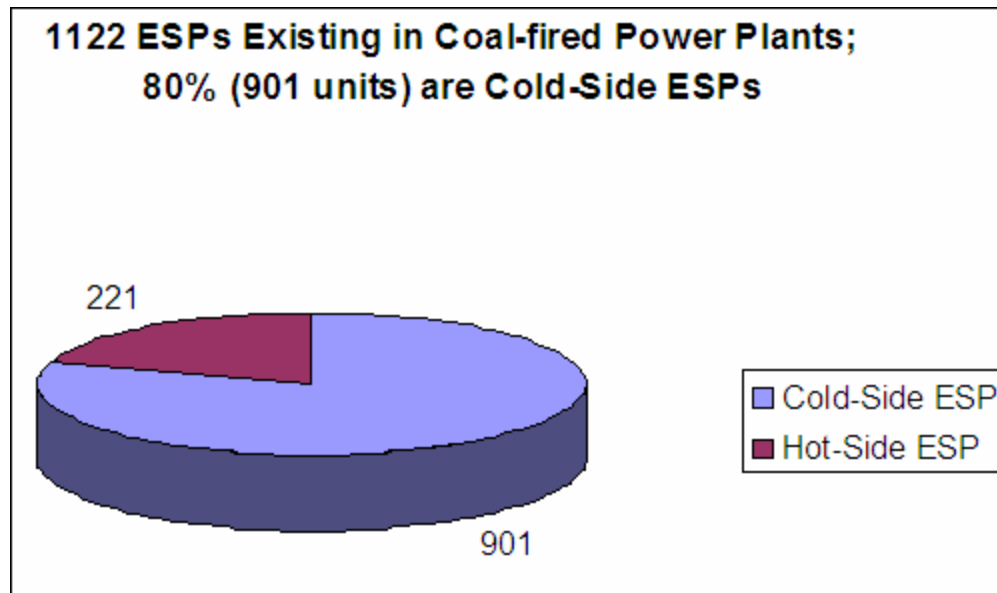
DNK = Do not know

Market Size

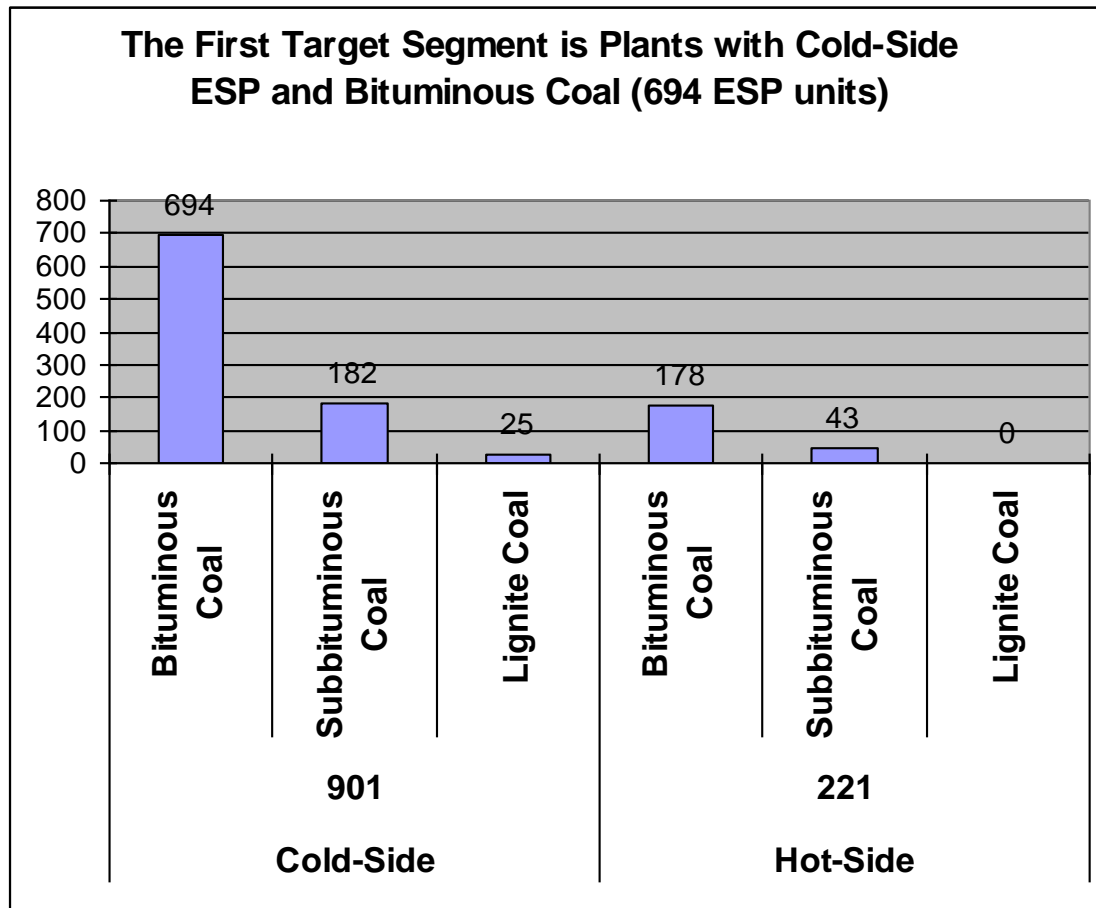


Market Size

The **Virtual Sorbent Bed (VSB)** is an attractive mercury pollution prevention technology for existing electrostatic precipitators (ESP), since these two technologies are compatible and can create **significant economical savings** through cooperation.



Market Segments



Strategy and Financials



EnPRO's Market Strategy

- Patenting and Licensing
- Partner with an Architectural Engineering Firm and/or an ESP manufacturer
 - Need specialized knowledge and additional resources.
 - Changes target market and how it is reached
 - Selling to distributor not to end-user

Financials - Approximations

Strategy	Percentage	Total	Present Value
Licensing - Low End	2%	\$2,110,000.00	\$787,391.07
-Little Development			
-As Is			
Licensing - Medium End	3%	\$3,165,000.00	\$1,181,086.60
-Minor Development			
-Little Continued Work			
Licensing - High End	5%	\$5,275,000.00	\$1,968,477.66
-Development			
-Exclusive License			

- Assumed \$500,000 Additional Value Added/ Unit
- Over 20 years

Risks and Assumptions



Risk Analysis



Technological Risks

- Sound in theory, but limited engineering data
 - Prototype design
 - Limited testing
- Unknown VSB efficiency
 - Estimate based on Activated Carbon control technology
- Unconfirmed VSB costs
 - Installation, Operating, Maintenance
- Developing in time for market demand
 - Market demand in 2010 and 2018
- Effects on other equipments' operations
 - Impact on the present role of the ESP
 - Operation of power plant's system overall

Risks (*Cont'*)

Marketing & Economic Risks

- Marketing based on concept
 - Sell VSB to clients with limited operational data
- Marketing late, compared to other competitors
 - “First come first serve”
- Managing mercury (Hg) as a by-product/waste
 - VSB focuses on removing Hg, not managing

Other Risks

- Unknown VSB dimension and space consumption
- VSB operates safely
- Sufficient funding to successfully develop VSB

Assumptions

Regulatory

- Coal-fired **power companies** will respond to mercury regulation

Technological

- VSB has **high efficiency (90+)**
 - Based on Activated Carbon technology
- VSB will **develop in time** for the market
 - Operating VSB unit for 2010 market
 - Fully tested and verified for 2018 market
- VSB will **not affect the functions** of other power plants' equipments, including ESP

Assumptions (*Cont.*)

Economic

- Resource & Market size are **limited**
 - Costly to invest in any control technology
- Primary VSB market: **Plants with ESP installed**
- VSB **unit price is \$500,000**
- Coal supply will continue to be **available and in demand**

Other Assumptions

- VSB is entering a **very competitive market**
- Profit and risks will determine the market strategy (i.e. licensing)

Path Forward

- Further Development of the Technology
- Additional Investigation into Financials
- Project should be continued
- Partner with chemical Engineering Capstone
- Marketing and Partnering

Questions

