EVALUATION OF BOTTOM ASH OF A COAL COMBUSTION PROCESS AS CONCRETE, CEMENT AND HIGHWAY BASE MATERIALS

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Introduction
Coal Demand for Energy Production

Cerrejón, Colombia

Circulating fluidized bed (CFB) facility at NorthamptonAllentown, Pennsylvania, USA (www.power-technology.com)

)

Tyrone Generating Station (coal-fired) and Haefling Combustion Turbine Station Kentucky, USA www.lgeenergy.com)

Coal Combustion Products
(The wastes disposal problem)

- Advanced Coal Technologies replacing Conventional Power Plants (2002, European Parliament)
- Fluidized-Bed Combustion (FBC) as most promising technology
- Coal Combustion Products (CCPs) 122.5 millions of tons (Kalyoncu Rustu. 2004. Us Geological Survey Coal Combustion Products: Production and Uses)
  - FLY ASH –58%
  - BOTTOM ASH –15.5%
  - BOILER SLAG- 2.5%
  - FGD -(FLUE GAS DESULPHURIZATION) 24%

Coal Combustion Products
(The wastes disposal problem)

- The accumulation of these by-products is causing an enormous environmental problem for disposal; unless an efficient resource recovery program can be, develop. (2003,Shi C, Qian J. Energy Sources 25: 617-628.)

- The levels of trace elements in thermal coals important in assessment of environmental impact (1992, Clarke and Sloss)

- The consequences of been expose to metal like, As, Ba, Cd, Cr, Pb, Hg, Ni, Se, Ag, dioxins, and furans presented in bottom ash (Show HY, Tay JH, Goh ATC 2003; Kaniraj SR, Gayathri, V 2004; Abel Raouf MW, Nowier HG 2004)

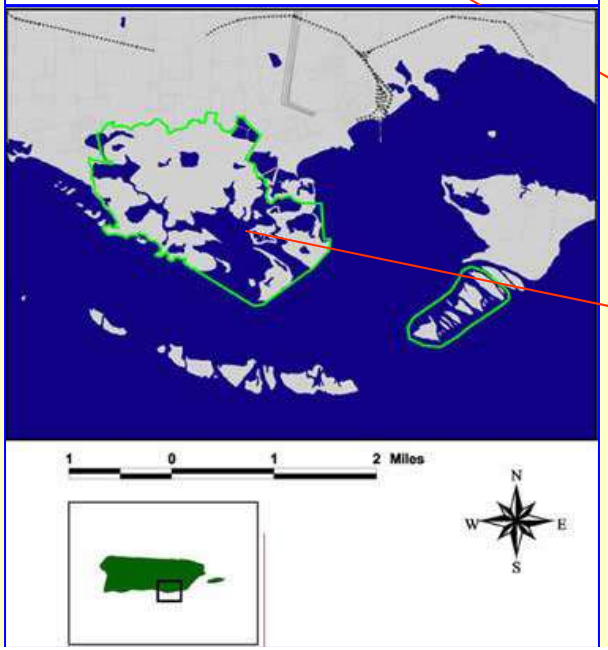
Advance Energy Systems Facility
Puerto Rico

454 MW (15% of the energy of PR) demand

25 years contract with PREPRA

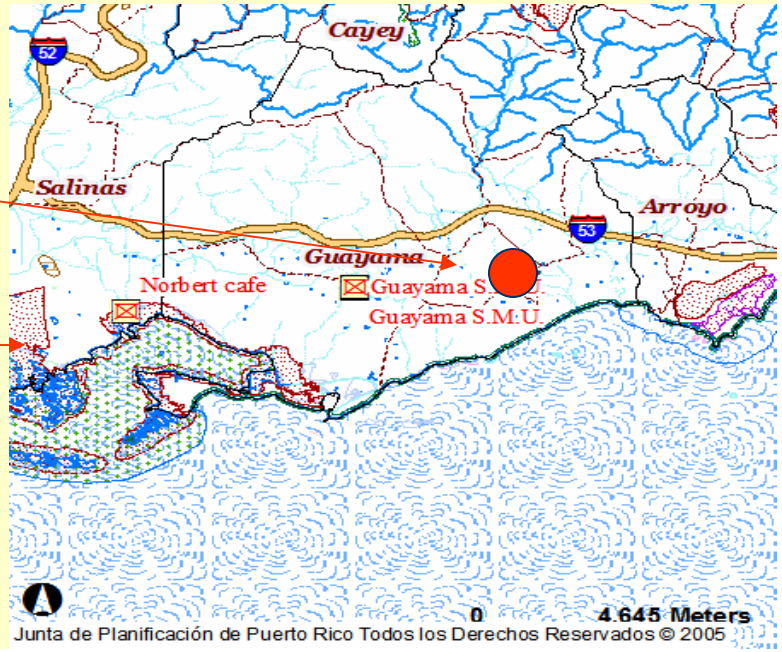
AES-Guayama, PR

Advance Energy Systems Facility
Guayama-Puerto Rico



AES PR

JOBOS BAY ESTUARINE RESERVE



Advance Energy Systems Facility
Puerto Rico

Advance Energy Systems Facility
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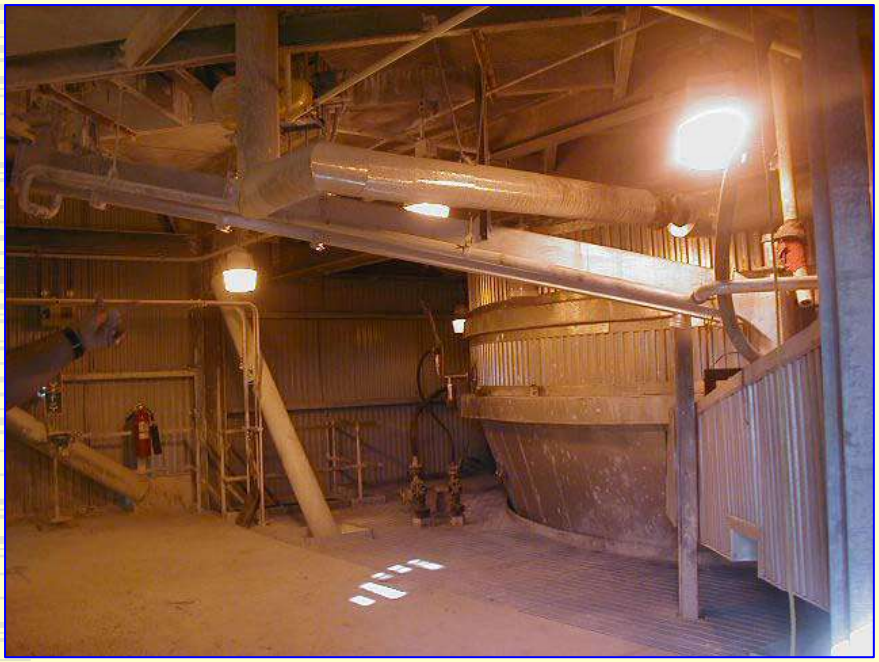
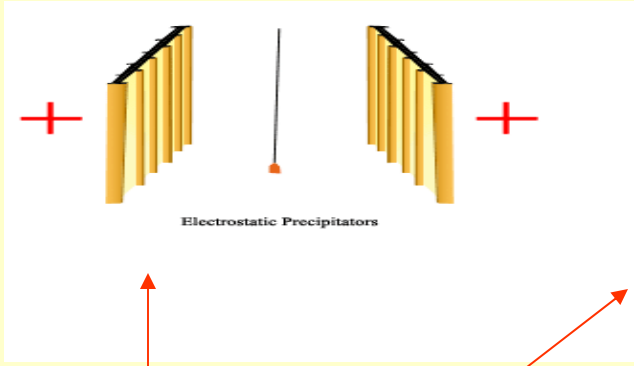


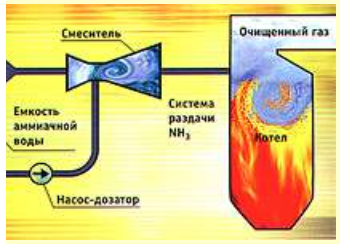
Electrostatic Precipitator

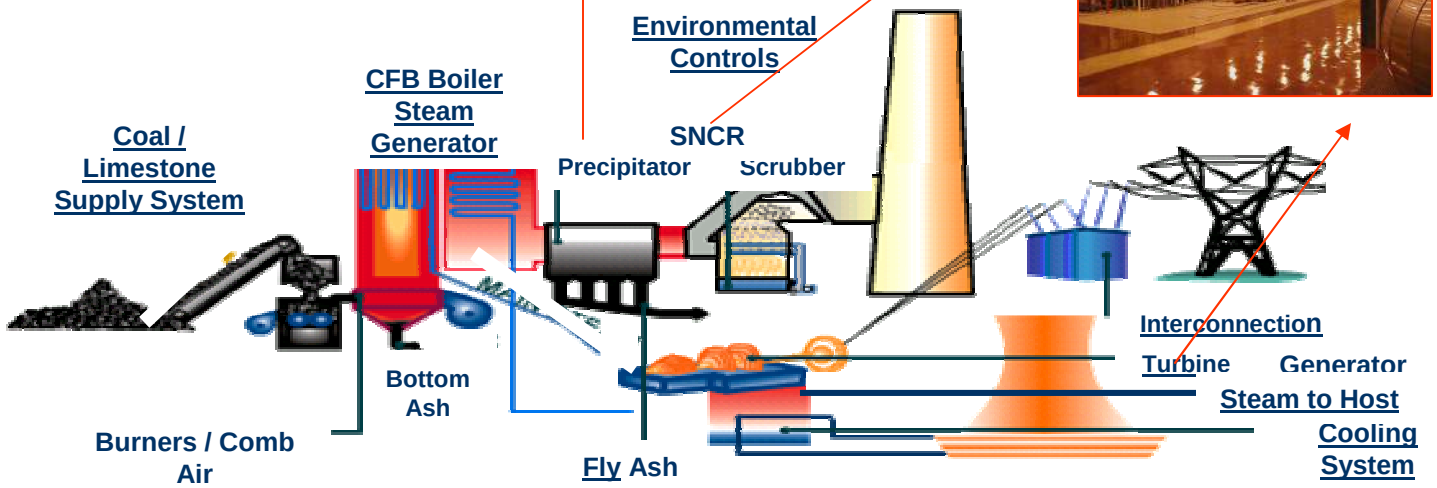
Limestone storage

AES Coal Combustion Process

- Bituminous Coal-Colombia
  - Sulfur 1%
  - Ash Content 10%
  - Caloric Content 11,000-13,000 BTU/pound
  - Fluidized Bed Temp 1550 - 1650°F



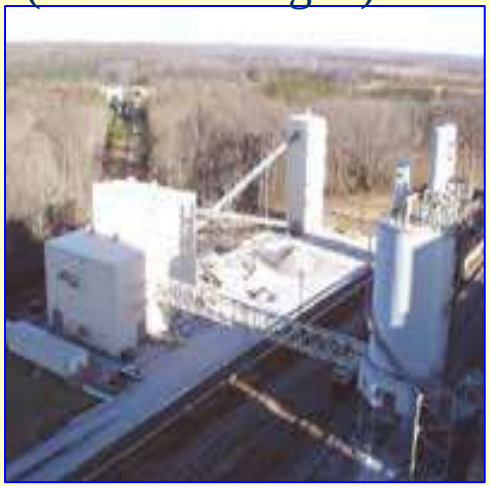




Research Objective
(The wastes disposal problem)

- EVALUATE THE PROPERTIES OF BOTTOM ASH OF A COAL COMBUSTION PROCESS AS CONCRETE , ASPHALT AND HIGHWAY BASE MATERIALS.

Universal Aggregate, LLC
Mirant's Birchwood Power
Facility -**Western Pennsylvania**
(www.fe.doe.gov)



Coal Combustion Products

(The wastes disposal problem)

The Bottom Ash Pile- AES Guayama, PR

Coal Combustion Products
(The wastes disposal problem)

- No proper disposal practices
  - Material send to Samaná, Dominican Republic-2003
    - "president Hipólito Mejia, former Vice-Minister of the Environment Rene Ledesma authorized to bring in at least 22 barge-loads (40,000 tons) of a substance rockash from a power plant in Puerto Rico to this township, with a similar amount being deposited in the port Arroyo Barril, in Samana province"
    - As, Cd, Be, Vn concentrations above the EPA, Chile, Brazil, Costa Rica, Bolivia standards.
    - Dermal and Respiratory conditions were reported.

Coal Combustion Products
(The wastes disposal problem)
Research Justification

2004, Dominican Republic Academic of Science – Bottom Ash , Samaná Province Report Register A2060.

Area	pH	TDS	Pb	As	Cd	Be	Ni	Cr	V
1	9.90	3,340	0.434	9.770	11.334	13.040	45.400	18.084	43.460
2	9.92	2,890	0.528	8.820	14.154	14.794	52.650	19.254	46.820
3	10.10	2,840	0.514	11.610	14.150	12.850	44.080	17.544	46.610
4	9.75	2,820	0.922	10.672	11.562	13.002	38.224	18.868	53.000
Bottom	9.97	3,030	0.762	6.106	13.854	13.160	35.690	19.644	55.030
Top	9.30	1,790	0.862	6.426	14.204	14.130	36.254	19.820	

AES Bottom Ash Trace Elements Content. ppm, AA – ASTM D-3683-94

Coal Combustion Products
(The wastes disposal problem)
Research Justification

- Material disposed on BFI Salinas Landfill

  - Cherry, Donald, S. Currie, Rebecca, J. Soucek, David, J. "Review of Global Adverse *Environmental Impacts to Ground Water and Aquatic Ecosystems from Coal Combustion Wastes*. 2000. Virginia Tech- Biology Department

  - 32 CCW disposal sites evaluated- Wisconsin, Illinois, New York, Massachusetts, Arizona, Alabama, North Dakota, Indiana, Savanna River Project-SC,Glen Lyn &Clinch River Plants-Virginia……
    - Levels of contamination in groundwater & ponds extremely high
    - Acute Toxicity
    - Enrichment of trace metal concentrations in ash
    - Substantive ecological damages due to pollutant's exposure
    - Substantive toxic impacts at lower levels of contamination

Toxics Threshold using the USEPA Test Organisms , *Ceriodaphnia dubia*, *Daphnia magna* to Select CCW Constituents Measured in LANDFILL Sites , Acute 48-hr LC endpoints from US EPA 1993a, 1994.

Trace Element	Max Concentration in Landfills Site	LC50 48-hr	Chronic End Point (7-25 days)
Al	66,000 g/L – 3000g/L	2,880 g/L	-------
Cd	1226 g/L-140 g/L	17-20 g/L	1.3-4.0 g/L
Fe	395-30 mg/L	1.16 mg/L	0.16-0.22 mg/L
Zn	51,580 g/L –184 g/L	70-353 g/L	40-140 g/L
Na	14,000 – 11,000 mg/L	900 mg/L	------
Se	1,100 - 320µg/L	---	10 g/L
TDS	36, 100 mg/L	2,640-6448 mg/L	----

Project Description & Methodology

- Characterization of raw materials and coal combustion waste products
  - Collect Coal , Limestone samples- MS, ICP, AA
  - Analyze for trace elements and constituents , MS, ICP ,AA
  - Bottom Ash Samples-Analyzes, MS, ICP, AA, TCLP
- Analyze bottom ash material properties against aggregate materials specification.
  - Hydrating and pelletize
  - Crush pellets, mix and produce a batch
  - Test the material
- Develop a Environmental Friendly Waste Management Plan for the bottom ash
  - Short term
  - Long term

Project Description & Methodology

- ASTM-Testing C-618-01 Standard Specification for Coal Fly Ash and Raw Calcined Natural for Use as a Mineral Admixture in Concrete
- ASTMC595-02a Standard Specification for Blended Hydraulics Cement
- American Society for Testing and Materials (ASTM) tests C131.
- American Society of State Highway Transportation Officials (AASHTO) specification M-283 for Class A aggregates
- ASTM D3987 leaching tests

AES- Puerto Rico, 2004

EXPECTED RESULTS

- Bottom Ash presents the adequate characteristics to be used as aggregated material in asphalt and concrete business.
- Low or Moderate Concentrations of Metal Elements in Bottom Ash
- Low or Moderate Concentrations of Metals Elements in Storm Water-runoff Ponds and Effluents
- Establish the Correlation Between Coal/limestone Characteristics and Bottom Ash Elements.

RESEARCH OPORTUNITIES

- Impact of Coal Combustion Plant in Concentration of Metal Trace Elements in Estuarine Sediments.
- Impact of Coal Combustion Plant in Mangrove Ecosystems in Bahía Jobos Estuarine Reserve and Las Mareas Bay, Guayama, PR.
- Relation between Fly Ash from a Coal Combustion Plan in the Incidence of Respiratory Conditions in Las Mareas Community, Guayama, PR
- Changes in Surface Water Chemistry and Quality as an Impact of Coal Combustion Plant.
- The Toxicity that presents the Coal Ashes to Marine Ecosystems such as Coral reef and Sea grass.