



# Coal Refuse Burning Co-Generation Plants

- Pennsylvania's partner in improving the environment



Nanty Glo East waste pile Photo courtesy of PADEP



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# Historical significance :

- Since commercial coal mining began in Pennsylvania prior to 1800, miners have extracted approximately 16.3 billion tons of coal from the Anthracite and Bituminous Coal Fields combined. The efforts of Pennsylvania's miners helped fuel the nation's industrial revolution and fed families for generations. However, the other legacy of the state's rich mining heritage is an unparalleled abandoned mine land (AML) problem.
- Mining operations continue today and will likely continue for at least another century.
- In the past coal that was very low in heat content (BTU's) and accordingly undesirable in the marketplace was randomly discarded all across Pennsylvania's landscape. This "waste coal" accumulated and lay idle on thousands of acres of land.
- Over time wind, rain, and other naturally occurring environmental conditions caused the piles of "waste coal" to alter and/or expand their "environmental fingerprint" on the Commonwealth's limited land resources.

# For nearly two centuries coal has been mined in Pennsylvania



V20376—Boys Picking Slate in a Great Coal Breaker,  
Anthracite Mines, Pennsylvania.

This “waste coal” accumulated and lay idle on thousands of acres of land



7069—Dumping Culm, Slate Pile, Anthracite Coal Minin  
Scranton, Pa., U. S. A.

# The Origins of Culm Banks

- Coal refuse or culm is the unwanted waste product of coal mining
- It's comprised of minerals and overburden (shale's, sandstones, quartzite, and conglomerates) extracted incidentally along with coal
- A separation process segregated waste from coal (but imperfectly) some coal was invariably discarded along with the culm
- Culm was dumped into piles that sometimes grew to millions of tons in the old days of mining
- Culm piles have been abandoned for decades and are common throughout the mining communities of Pennsylvania's Coal Country

**More than 5000 abandoned, un-reclaimed mine  
problem areas encompassing more than  
189,000 acres in Pennsylvania**



7070—Miners' Wives and Children Picking Coal from the Dump,  
Scranton, Pa., U. S. A.

# Common throughout the mining communities of PA's Coal Country



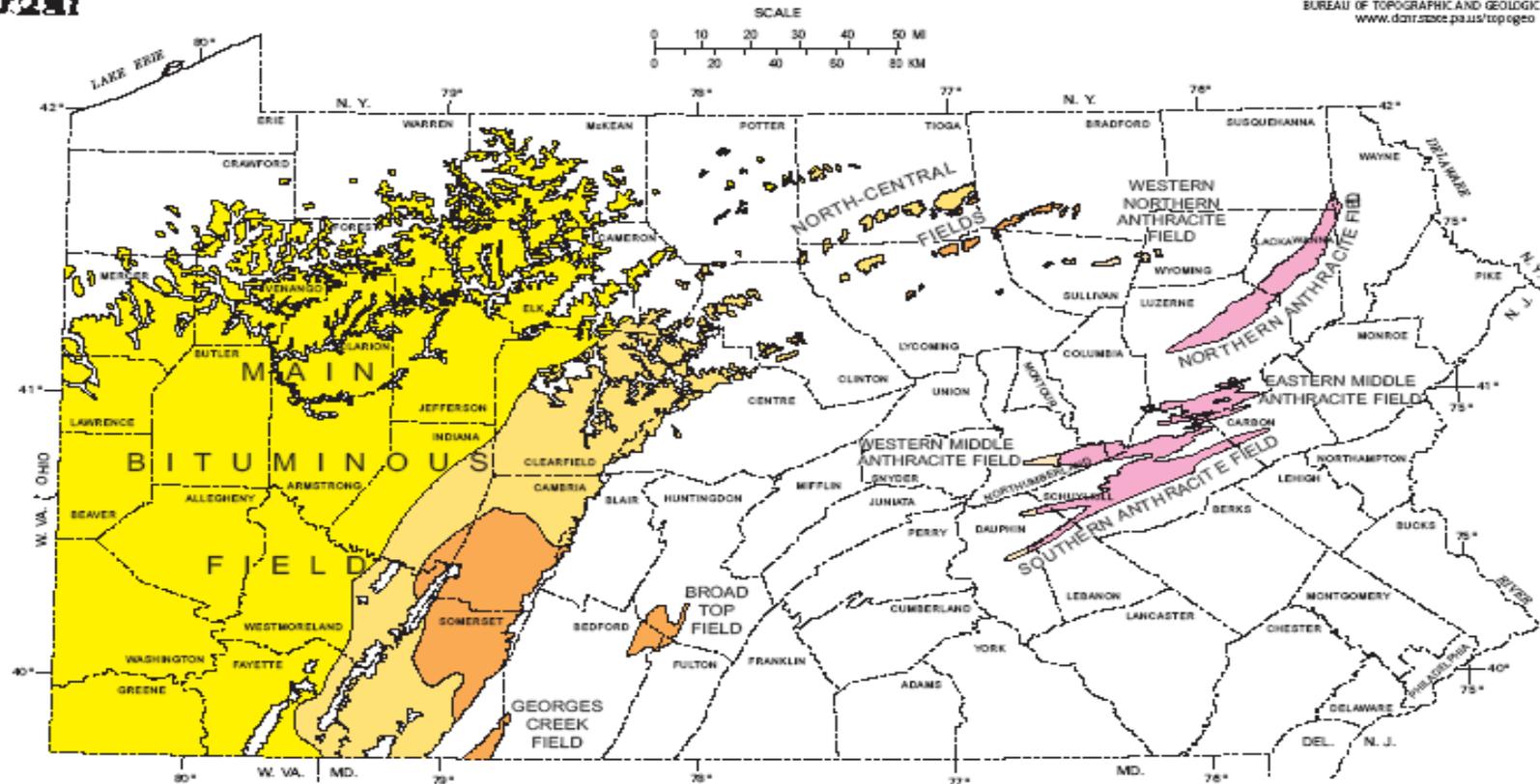
# Distribution of PA Coals

MAP 11



## DISTRIBUTION OF PENNSYLVANIA COALS

COMMONWEALTH OF PENNSYLVANIA  
DEPARTMENT OF  
CONSERVATION AND NATURAL RESOURCES  
BUREAU OF TOPOGRAPHIC AND GEOLOGIC SURVEY  
[www.dcnr.state.pa.us/topogeo](http://www.dcnr.state.pa.us/topogeo)



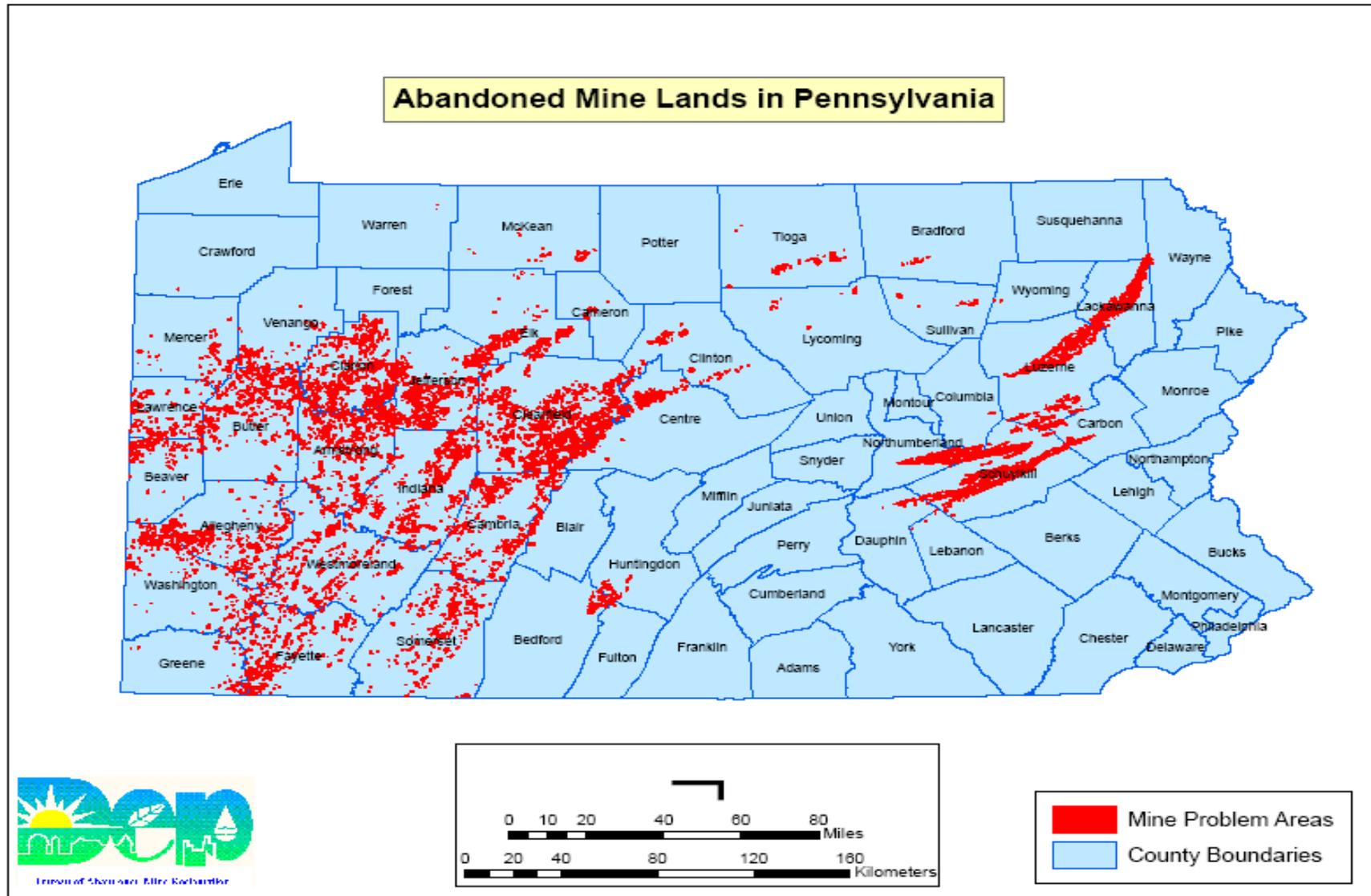
### EXPLANATION



**Over 820 abandoned coal refuse piles...  
over 8,500 acres...over 212,465,000 cubic  
yards...millions of tons of coal refuse**



# Abandoned Mine Lands in PA



# Waste-Coal!

In the early days of coal mining, waste-coal was discarded because poor quality coal could not be burned using the technology of the day.

Much of this refuse was left in large waste piles near the coal mines.

Unlike most coal-fired power plants, ARIPPA plants burn “waste-coal”



**These waste piles are up to 300 feet tall and can run for thousands of feet.**

# The problems with Culm Banks

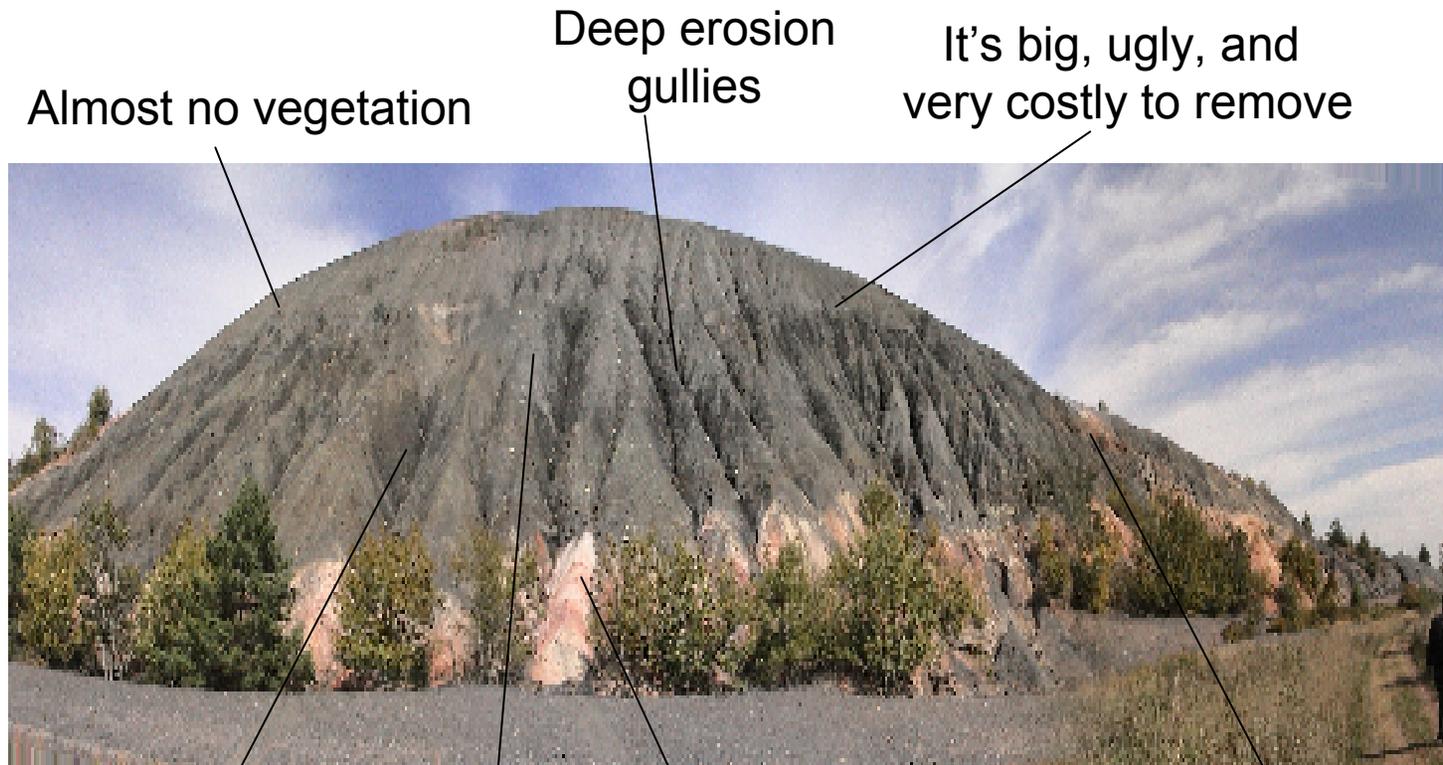
- Huge, ugly eyesores
- Dangerous, unstable and highly eroded steep slopes
- Culm will not support much vegetation
- Sometimes piles catch on fire and burn for years
- **Sources of abandoned mine drainage (AMD)**
  - **Culm piles create the perfect conditions for generating AMD. Sulfur bearing minerals (pyrites), when exposed to water and air (the weather), generate acids and heavy metals which are quite harmful to streams and rivers.**
- Devalued property values and communities
- Reclamation is too often prohibitively expensive
- Economic value of the lands left unreclaimed is greatly reduced



Much of this refuse was left in large waste piles near the coal mines.



# Typical Features of an Abandoned Culm Bank



Almost no vegetation

Deep erosion gullies

It's big, ugly, and very costly to remove

Treacherous terrain

Evidence of past burning

Unstabilized dust stirred up by the wind, causing local air pollution

Exposure of pyritic material to the weather creates acid mine drainage

**Coal refuse goes by many names**

- Culm Piles
- Gob Piles
- Mine Rock
- Mine Dumps
- Boney Piles
- Slate Dumps
- Culm Banks
- Black Deserts
- Moon Scapes

**Million tons of discarded “waste coal” covering 1000’s of acres**



# The BAMR-estimated price tag to eliminate Pennsylvania's AML problems is a staggering \$14.6 billion.

PA suffers from up to 3,100 miles of streams degraded by acid mine drainage (AMD) as a result of abandoned mines

AMD is Pennsylvania's most serious stream pollution problem.



**Location near fuel, water, and roadways is vital**

Aerial photo circa 1988 showing the Revloc sites



# SCMRA August 1977

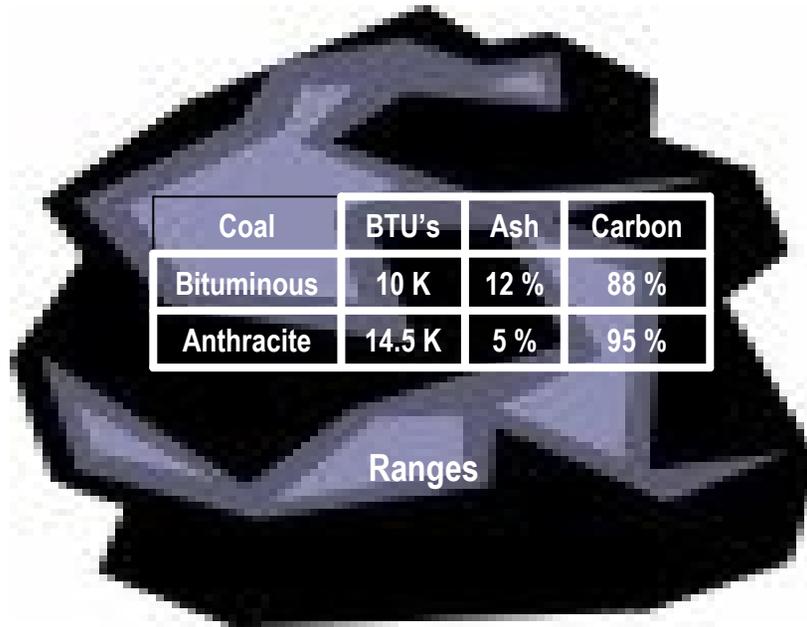
- SCMRA, which applies to all surface mining conducted after August 1977, requires complete reclamation of surface mine-affected lands and requires the posting of financial assurances, usually in the form of bonds, to ensure reclamation.

# Types of Coal

2500°  
Average  
Temperature

**Grades of Coal:**

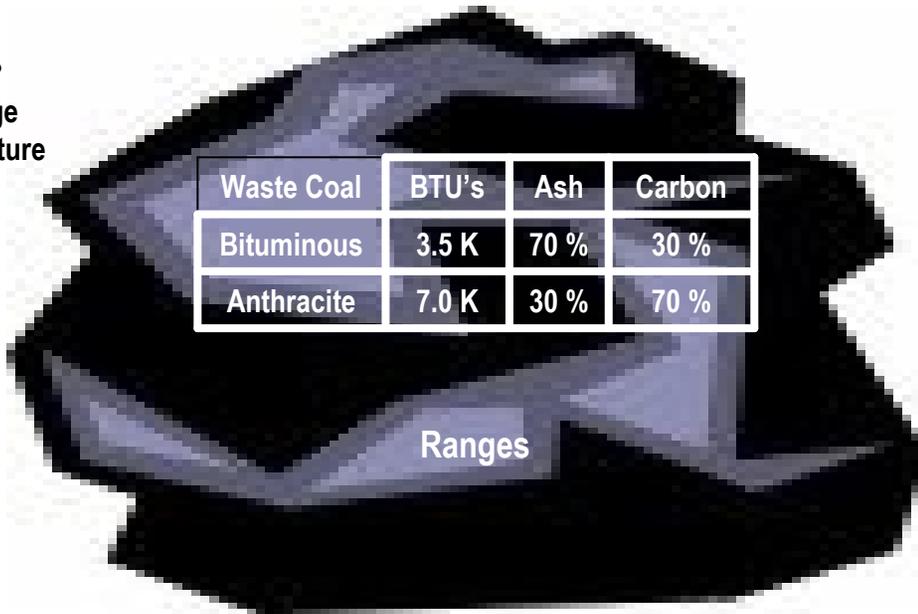
- Metric Anthracite
- Anthracite
- Bituminous
- Sub Bituminous
- Lignite



## Coal

Average =  
7 % Ash, 93 % Carbon  
13,000 BTU

1700°  
Average  
Temperature



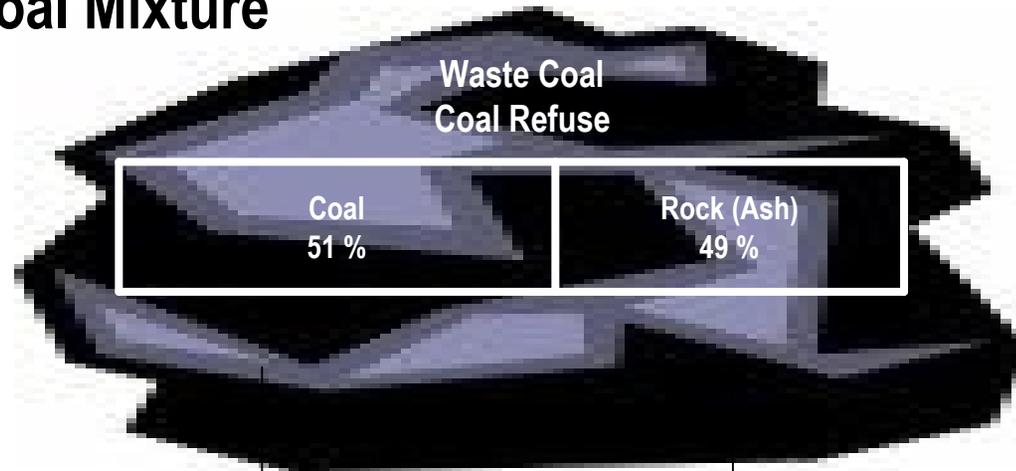
## Waste Coal

Average =  
49 % Ash, 51 % Carbon  
5,000 BTU (4336)

96-97 Parts of Waste Coal  
and 3-4 Parts of Limestone  
Are added to produce the  
final mixture

# CFB Waste Coal Mixture

90 - 97 %



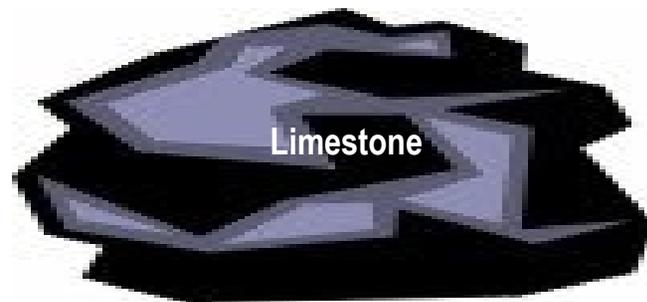
Carbon

Illite  
Kaolinite  
Pyrophyllite  
Pyrite (Sulphur)  
Rutile

## Waste Coal

### Plus

3 - 10 %



## Limestone

Limestone Added (All Rock 100% Ash) to control SO<sub>2</sub> levels.

Carbon is the key component that burns. Ash is the naturally occurring “rocks” elements found in the local area. When a “lump” of coal is burned the ash that remains is the rock elements (%) found in the lump of coal. The carbon burns off to produce energy.

# “PURPA,” the Public Utility Regulatory Policies Act Technology, and private investors

- In 1978, Congress enacted “PURPA,”** the Public Utility Regulatory Policies Act, to encourage “greater use of highly efficient low emitting co-generation technology “to meet nations electricity needs””
- Technology, coordinated legislative activity, and private investors together developed a cost effective, environmentally friendly, “beneficial use” solution to the millions of tons of waste coal.
  - Electrical sales were guaranteed at an “avoided cost price” through Power Purchase Agreements (many such agreements have expired or will over the next decade) between large utility generators and the new alternate energy non-utility generators (the generating capacity size of these generators were purposely limited through PURPA)
  - Perceived to be a ‘win-win-win’ situation: political, business, consumer and environmental aspects.
  - **From 1985 to 1995**, most electric generating plants utilizing waste coal were constructed
  - **In 2001, PURPA** was reaffirmed as a means to increase cogeneration capacity

# CFB Boilers Introduction

Fueling their boilers with **culm**, the waste product from the old coal mining days, coal refuse burning power plants annually rid the environment of millions of tons of ugly, polluting coal refuse and waste piles that have been fixtures of Pennsylvania's landscape for decades.



# Technology makes it possible

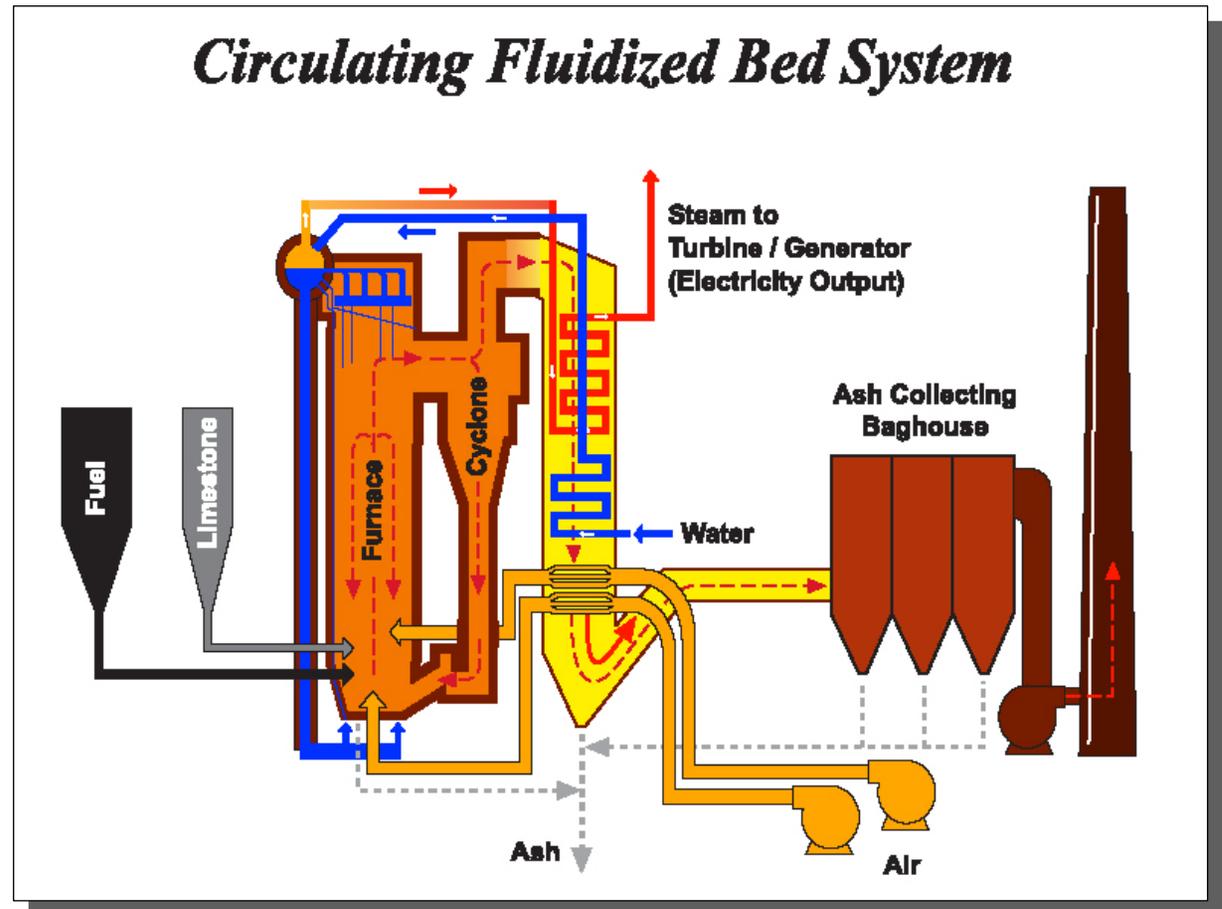
- Coal refuse or culm banks have some residual coal; Culm can now be economically burned because of advanced technology
- The technology offers the cleanest burning, minimally polluting coal-fired power generating stations in the world
- As a bonus, even the byproduct ash of coal refuse combustion has a beneficial use in abandoned mine reclamation projects.



# The CFB Boiler... the technology that “made it work”

The CFB is actually considered a low temperature boiler – even though temperatures are maintained at 1,600 degrees Fahrenheit.

This low temperature greatly minimizes the formation of Oxides of Nitrogen – a precursor to the formation of smog.



The CFB Boiler represents only one of many stages.

## The technology: burning *Culm* to produce *electricity*

- Culm is burned in specialized containers called **Circulating Fluidized Bed (CFB) Boilers**

*CFB boilers are the breakthrough technology enabling the economical burning of low grade fuels such as coal refuse*

- Pulverized coal refuse **and limestone** are injected into the CFB boiler along with strong jets of hot air
- The solid material circulates in the boiler as it **completely burns** in the turbulent environment
- The burning fuel creates the heat to produce steam which in turn drives electric generators

# CFB Boiler Co-Generation Plant Flow Chart

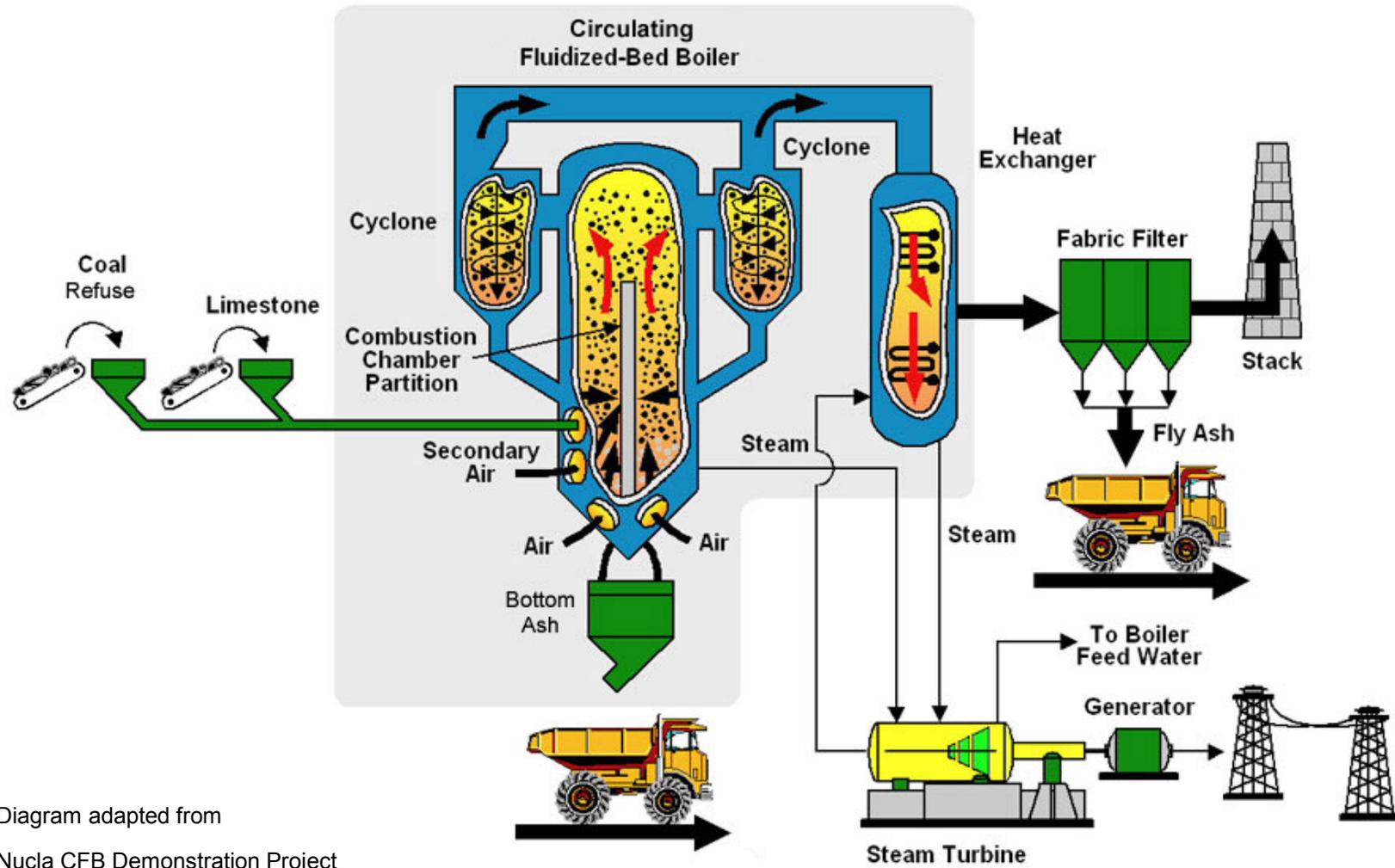
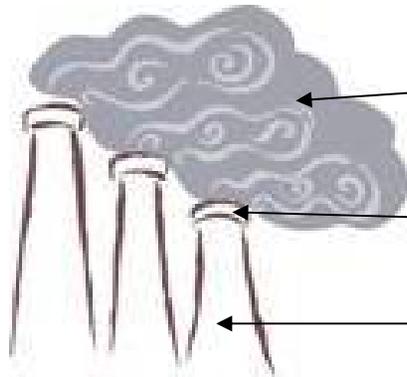


Diagram adapted from  
Nucla CFB Demonstration Project

# CFB Environmental Controls



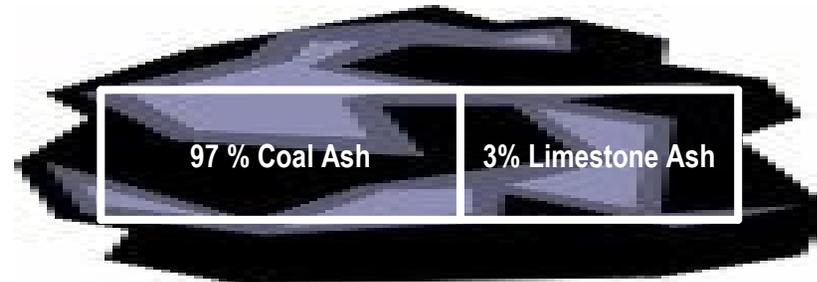
**AIR**

SO<sub>2</sub>  
NO<sub>2</sub>  
Mercury  
Opacity  
CO<sub>2</sub>

Stack/Chimney

Fuel (Wood/Coal)

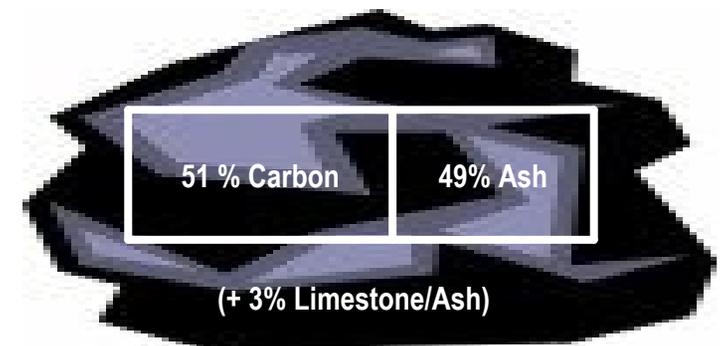
**ASH –  
(Beneficial Use)**



CFB Waste  
Coal Ash

## Monitored Controlled Elements Found in Carbon Burning (Coal) Process:

1. Sulphur (SO<sub>2</sub>) – Limestone Control
2. Nitrogen (NO<sub>2</sub>) – Low Temperature – More Oxygen
3. Mercury
4. Opacity (Particulates PM 10 – 5 – 2.5)
5. CO<sub>2</sub>
6. Water (Cooling + Storm Water Controls)



### CFB Ash Content

The Waste Coal/Limestone Mixture is very alkaline ash with low permeability and benign chemical properties, making it safe and ideal for abandoned mine reclamation.

# Introduction: The Plants are Born

- A new kind of electricity generation power plant is changing the landscape of Pennsylvania's Anthracite and Bituminous Coalfields...

*...for the better!*



Piney Creek @30 MGW  
the smallest CFB waste coal burning  
facility in PA



# Description of ARIPPA Member Facilities:

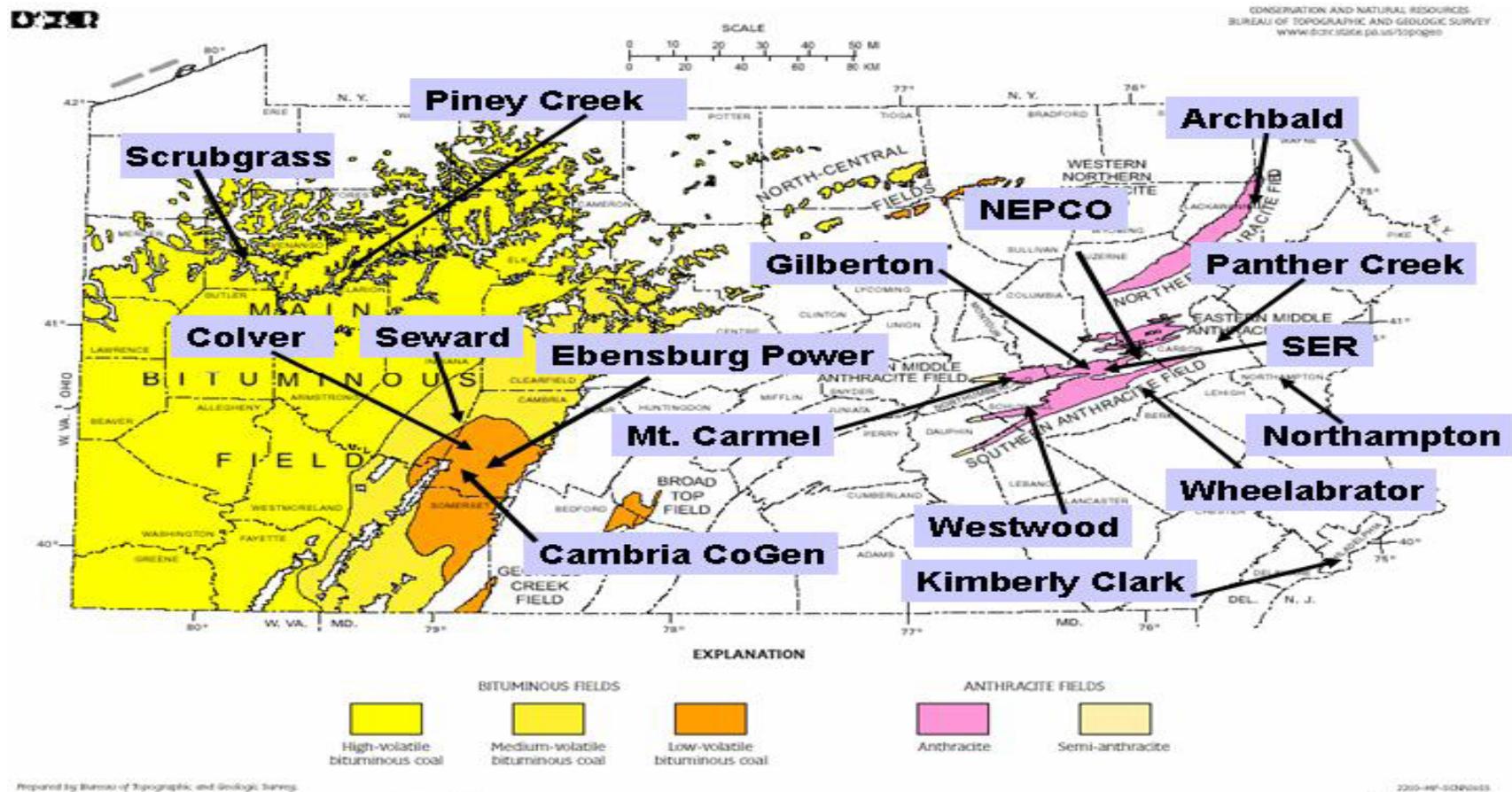
- ARIPPA's thirteen member facilities constitute the overwhelming majority of the waste coal power production industry in the country.
- Each of the ARIPPA member facilities uses a stationary coal-fired boiler that serves a generator with a nameplate capacity of more than 25 MWe and produces electricity for sale.
- The ARIPPA facilities provide a unique environmental benefit in Pennsylvania by burning waste coal as fuel and utilizing circulating fluidized bed ("CFB") technology.
- ARIPPA facilities utilize coal refuse from both past and current mining activities, and thereby reclaim abandoned strip mines and abate acid mine drainage from waste coal piles at no cost to Pennsylvania taxpayers.
- By combusting waste coal piles, ARIPPA members are removing one of the principal sources of contamination to surface water and groundwater in Pennsylvania.
- In addition to the environmental benefits resulting from the combustion of waste coal, ARIPPA facilities have minimized the air emissions traditionally associated with coal-fired electricity generation by incorporating state-of-the-art, clean coal technology utilizing CFB boilers.
- Because the CFB units are designed as inherently clean burning sources of electricity, they emit potentially air pollutants, at significantly reduced rates relative to conventional coal-fired utility units.

# Westwood FBC plant near Tremont in Southern Anthracite Field



# Distribution of the CFB power plants in Pennsylvania.

These units met the most stringent of the emissions regulations mandated by the Clean Air Act of 1970.



# The Beginning of the win-win-win



# Reliant Energy BEFORE 1921

Bituminous  
Coal  
196 MW net

Note the  
upper left  
corner of  
photo shows  
waste coal  
remaining  
from original  
mining  
operation.



# Reliant-Seward - Cleaning Up Site

- Waste coal at site has been remediated
- Left over from historic coal mining activities (2,000,000 Tons)

Neutralized in place and forms base for new plant

- Used CFB Ash (2,200,000 Tons)
- Reduces AMD into Conemaugh River
- Old plant demolished

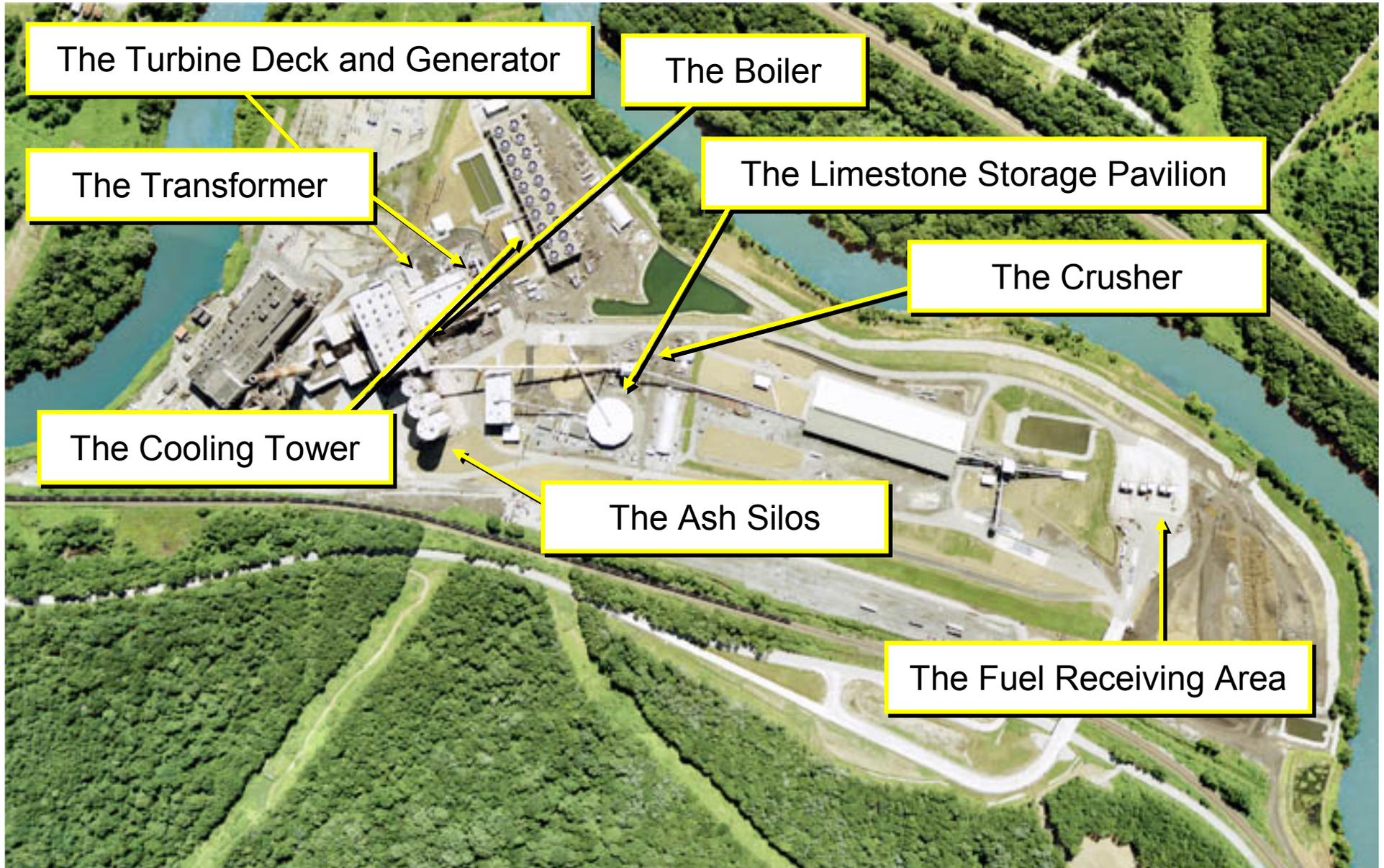


# Reliant Energy AFTER

An environmental and engineering marvel.  
It is the largest waste-coal fired generating station in the world and the largest merchant plant of its kind in the United States.  
It recently won a prestigious industry award – 2004 Plant of the Year by Platt's POWER magazine



# Common waste coal electric generating plant layout



# Waste Coal Fuel Specifications Vary:

## Seward Fuel/Processing

<b>HHV</b>	<b>5500 BTU/LB</b>
• <b>Ash</b>	<b>51.0%</b>
• <b>Sulphur</b>	<b>2.75%</b>
• <b>Moisture</b>	<b>8.7%</b>
• <b>VOL</b>	<b>11.0%</b>

## Piney Creek Fuel/Processing

<b>Carbon</b>	<b>31-41%</b>
<b>Hydrogen</b>	<b>2.7-4.1%</b>
<b>Nitrogen</b>	<b>.4-.7%</b>
<b>Sulfur</b>	<b>4.0-4.5%</b>
<b>Ash</b>	<b>37-48%</b>
<b>Oxygen</b>	<b>4.5-8.0%</b>
<b>Moisture</b>	<b>4.7-11.0%</b>
<b>HHV</b>	<b>6500-7500 btu/lb</b>



# The Fuel Delivery Area

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Fuel is delivered to ARIPPA plants via truck.

During a typical work week trucks deliver hundreds of tons of waste-coal.

Each site must also design plans to handle fuel delivery disruptions due to weather or other factors

In addition, truck loads of limestone are delivered to mix with the waste coal

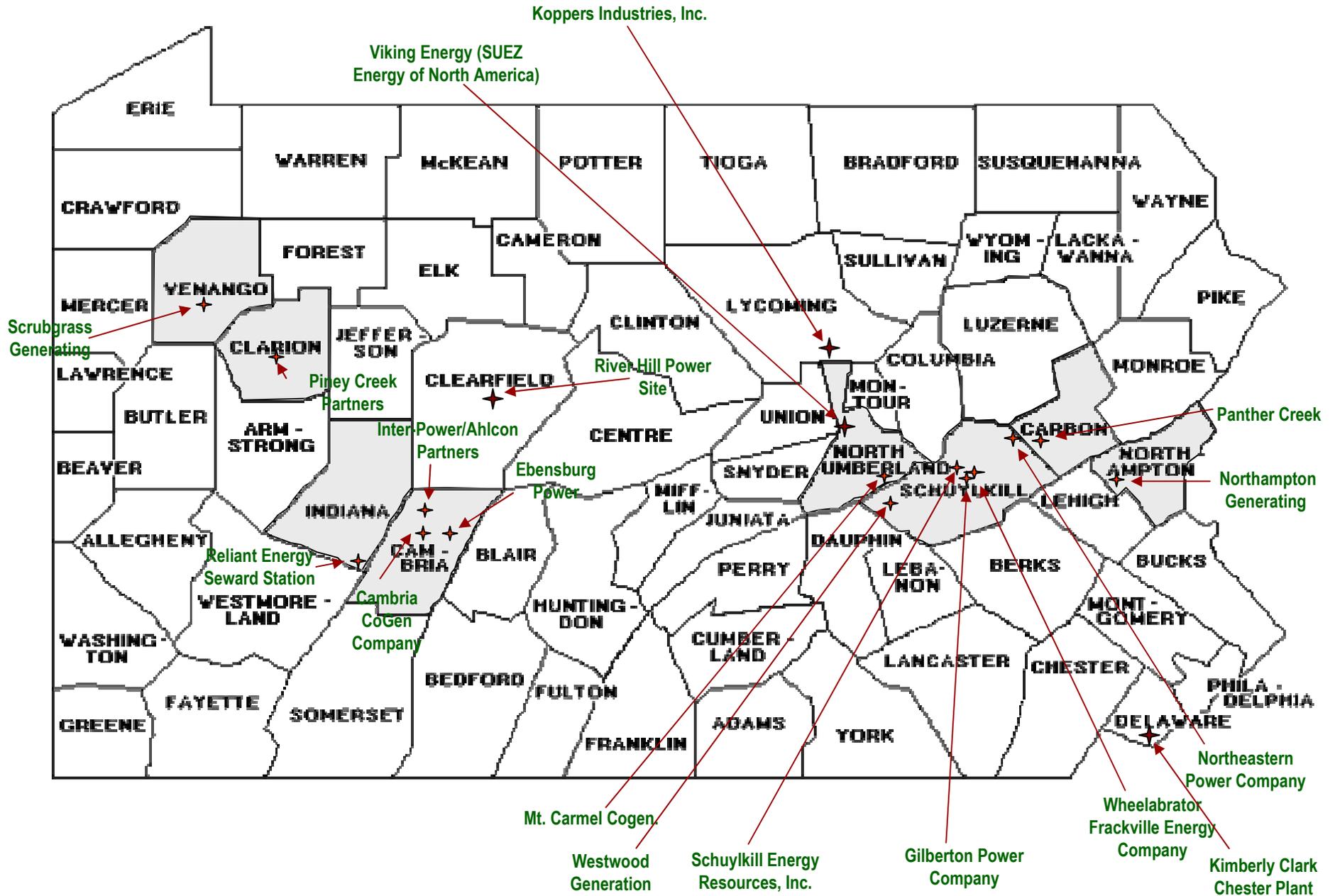


**The trucks deliver the coal to the receiving area.**



## Organized in 1987-88

- ARIPPA is a trade association comprised currently of thirteen (13) waste coal-fired electric generating plants.
- ARIPPA represents the owners and operators of these independent, non-utility electric power generation stations.
- ARIPPA member plants are located in the anthracite and bituminous coal regions of the United States.
- ARIPPA is unique among the "cogeneration associations" ... sustaining plant members are all operating fossil fuel-waste coal fired- power plants utilizing circulating fluidized bed combustion technology.



# ARIPPA Services and Issues

- Three types of membership: Sustaining, Supporting, and Associate...each with specific advantages and opportunities!
- Lobbying/Litigation on behalf of the industry State level and National
- **Free** listing (with links) on our website **ARIPPA.ORG**, **Free** access to the database of contacts and a Free bi-annual copy (searchable electronic or hardcopy format) **ARIPPA Membership Directory**
- **Free** attendance at our Educational Monthly Meetings and 2 Social Events
- **Free** one time opportunity to speak/market at a Monthly Meeting
- **Free** periodic industry newsletters
- Access to our Annual Tech Convention Symposium/Trade Show:  
Annually in August @ Sheraton Harrisburg-Hershey PA
- Access to our Annual PAC Golf Outing (Annually in August also)

# ARIPPA Services and Issues

## PA STATE ISSUES...

- Air Quality Permits/Streamlining
- Alternate Energy Credits
- Alternate sources of Energy as Mixture
- Abandoned Mine Lands/AMD/Bonding
- Ash: Beneficial Use
- CAIR AIR
- CAMR/MERCURY
- New Source Review
- Water Resources
- Waste Municipal and Residual
  
- Energy Development Authority
- PADEP
- Advisory Committees... EQB
- Public Utility Commission/Regs NUG's
  
- LEGISLATIVE BRANCH:
- Climate Global Warming/Carbon Dioxide

# A “true partnership”: our industry... and the goals and ideals of the PADEP

- With technological advancements and support from government and investors a beneficial use was finally developed to utilize “waste coal” in quantity.
- This beneficial use today generates electricity to meet the energy needs of hundreds of thousands of Pennsylvania households.
- Understanding the unique environmental advantages of the continued beneficial use of waste coal is pivotal to understanding the true partnership our industry shares with the goals and ideals of the PADEP

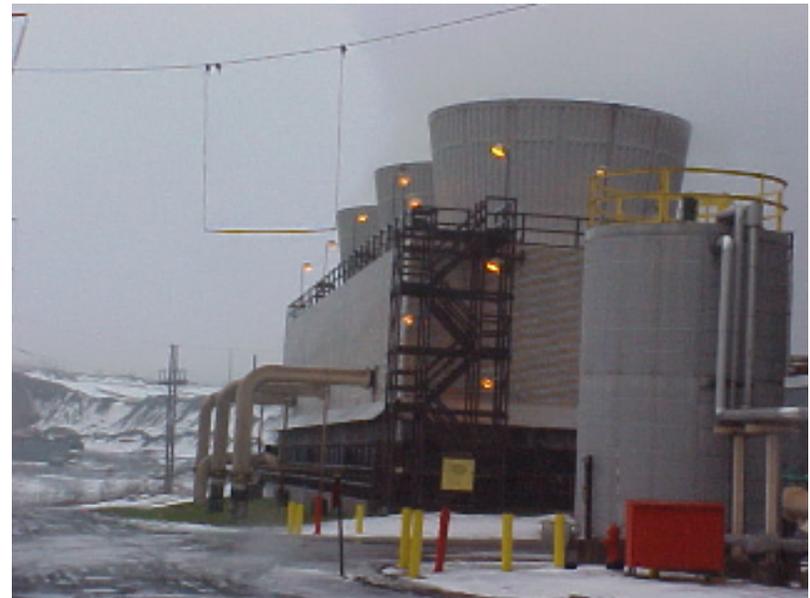
# ARIPPA Services and Issues

- NATIONAL ISSUES; EPA and EPA: FERC: Others
- ORGANIZATIONS: CIBO PJM ACCCE ACAA
- FEDERAL GOVERNMENT:
  - Acid rain:
  - AML trust fund:
  - Ash-OSM
  - New Source Review
  - Pm 2.5 (particulate matter):
- Legislative Branch:
  - Climate Global Warming/Carbon Dioxide
  - PURPA

# A win-win situation

- Coal refuse burning power plants offer the single greatest hope for the widespread reclamation of abandoned coal refuse piles...

*... and they do it  
without taxpayer dollars  
and the end result is a  
cleaner environment!*



# CFB Ash & Pollution Controls

- Practically complete combustion of Culm at relatively low operating temperatures minimizes nitrogen oxide ( $\text{NO}_x$ ) air pollution formation
- Limestone combines with sulfur compounds in the Culm to create an inert solid that is captured to minimize airborne sulfur ( $\text{SO}_x$ ) emissions
- A fabric filter captures lighter particulate matter, the fly ash
- CFB boilers fitted with appropriate pollution controls meet or exceed the strictest air pollution requirements for regulations under PA's Clean Air Act



# After the Waste Coal is Burned “Ash” remains

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The Ash Silos contain the ash that is produced in the combustion process.

The first two silos hold the light-weight “Flyash” and the third silo holds the heavier bed ash.



# Combustion Byproducts: CFB Ash

- Following combustion of Culm in the CFB boiler, the solids that remain are called ash
- Heavier ash collected at the bottom of the CFB boiler is “bottom ash”
- Lighter ash collected in the fabric collector is “fly ash”
- CFB ash is **alkaline** (not capable of producing acidity) because of the limestone added to control sulfur emissions
- CFB ash is suitable for reclamation projects involving beneficiation of acid-producing materials and filling of surface-mine pits and deep-mine voids because of its low permeability and benign chemical properties
- Ash from other types of power plants usually doesn't have the alkalinity of CFB ash, and not the usefulness

# Beneficial Use Ash reclaims valuable land

After depositing their loads of waste-coal in the Fuel Receiving Area, many trucks proceed to the Ash Silos.

There, they pull beneath a silo and retrieve a load of fly or bed ash.

Often the trucks transport the ash to the site of a former waste pile. The alkaline rich ash is used to neutralize the acidic soil – reclaiming once unusable land with once unusable coal.



**The bed ash is still hot from the combustion process.**

# **Use of CFB Ash in Culm Bank Reclamation on Abandoned Mine Lands**

- Heavy metals present in acidic environments (as are common in mining impacted lands) are very mobile and tend to leach to surrounding soils and waters; CFB ash can neutralize acidity and can help to immobilize the metals to prevent leaching... a vast improvement
- Alkaline CFB Ash is often hauled back to the same Culm pile sites used for CFB fuel; The haul back avoids the costs of landfilling the CFB Ash
- The land the Culm piles occupied are typically very acidic from abandoned mine drainage and surface water runoff and leaching from leaching and erosion of the banks
- The alkaline ash is mixed with the acidic conditions of the abandoned mine lands for neutralization and metals immobilization and serves as an agronomic benefit to the soil

# Low permeability and benign chemical properties



# CFB Ash Use is Safe, Tested and Regulated

- Reputable research indicates CFB Ash is a safe material for abandoned mine land reclamation projects
- CFB ash is routinely tested for content, and is regulated by PADEP, which has certified it for beneficial use in mining-impacted reclamation projects
- CFB Ash has an exemplary record as a reclamation material
- Unfortunately, disparaging claims have been made regarding its suitability for reclamation projects However, no claim that CFB ash is unsuitable for use as a reclamation material has ever been scientifically substantiated

# **CFB Ash has an exemplary record as a reclamation material**



# Economics of Abandoned Mine Reclamation of Culm Banks

- The ability to use the refuse material as CFB fuel of any particular Culm pile is dependent a variety of factors...  
... but it all hinges on the economics of making a profit for the power plant operator

Important considerations affecting the cost of operations include:

- **Energy content of Culm material (BTU value)**
- **The distance of the pile to the Co-Gen Plant**
- **The sulfur content of the material**
- **Moisture and clay content**
- **Accessibility to the location and site characteristics of the pile**
- **The ability to use CFB Ash on the site**
- **Negotiations with the pile owner**

# Culm Pile Removal and Reclamation Adds tremendous Value to the Environment

- Not only are the CFB Co-Generation Plants responsible for removing the coal refuse material, they totally reclaim the pile site to productive use, often using CFB ash



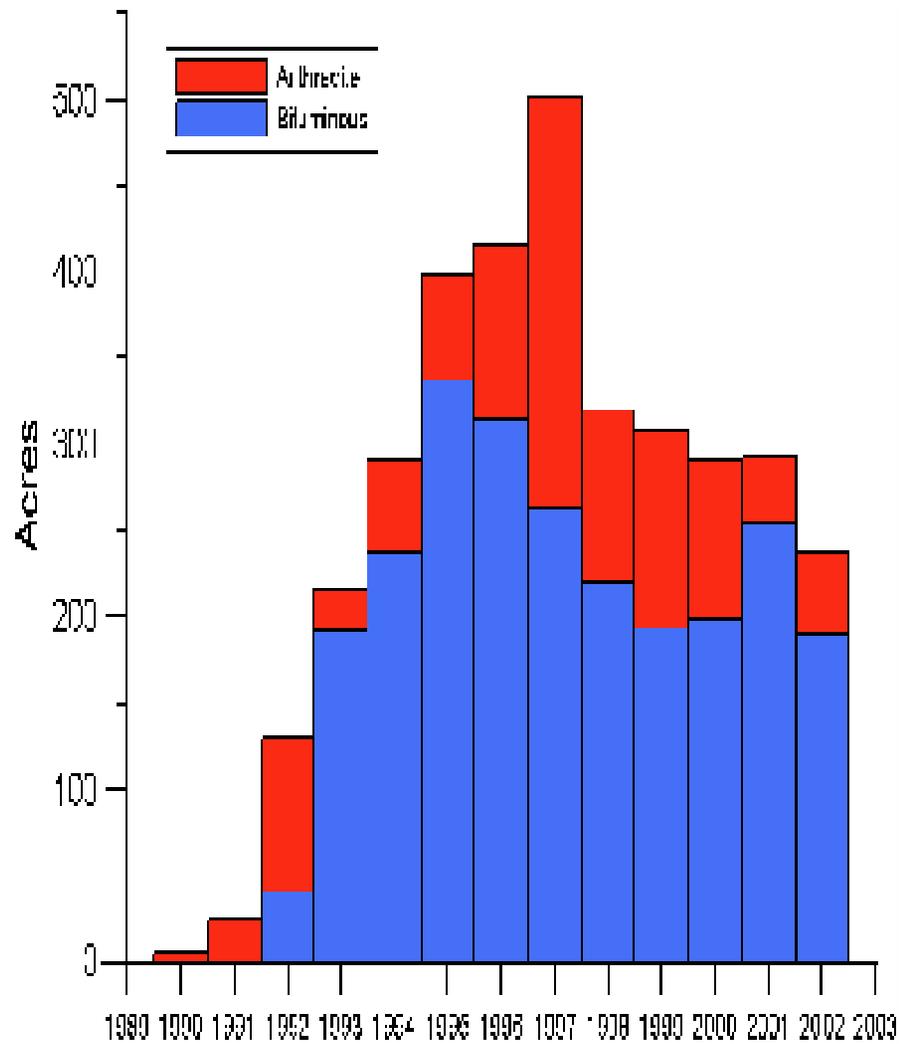
# Tera D. Buckley Marketing Research Specialist University of North Dakota Energy & Environmental Research Center for EPA

## “CONCLUSIONS

- Pennsylvania’s estimated 60%–70% CCP utilization rate is due largely to the fact that CCP use in mining applications is defined as a beneficial use in Pennsylvania, unlike many other states that consider it to be disposal. PA DEP residual waste coal ash beneficial use regulations and program implementation policies are perhaps the most comprehensive and dependable in the country, particularly for abandoned mine reclamation. These regulations coupled with the state’s 14 CFB power plants successfully using CCPs in mine applications make Pennsylvania a model state for the use of CCPs in mine applications.”

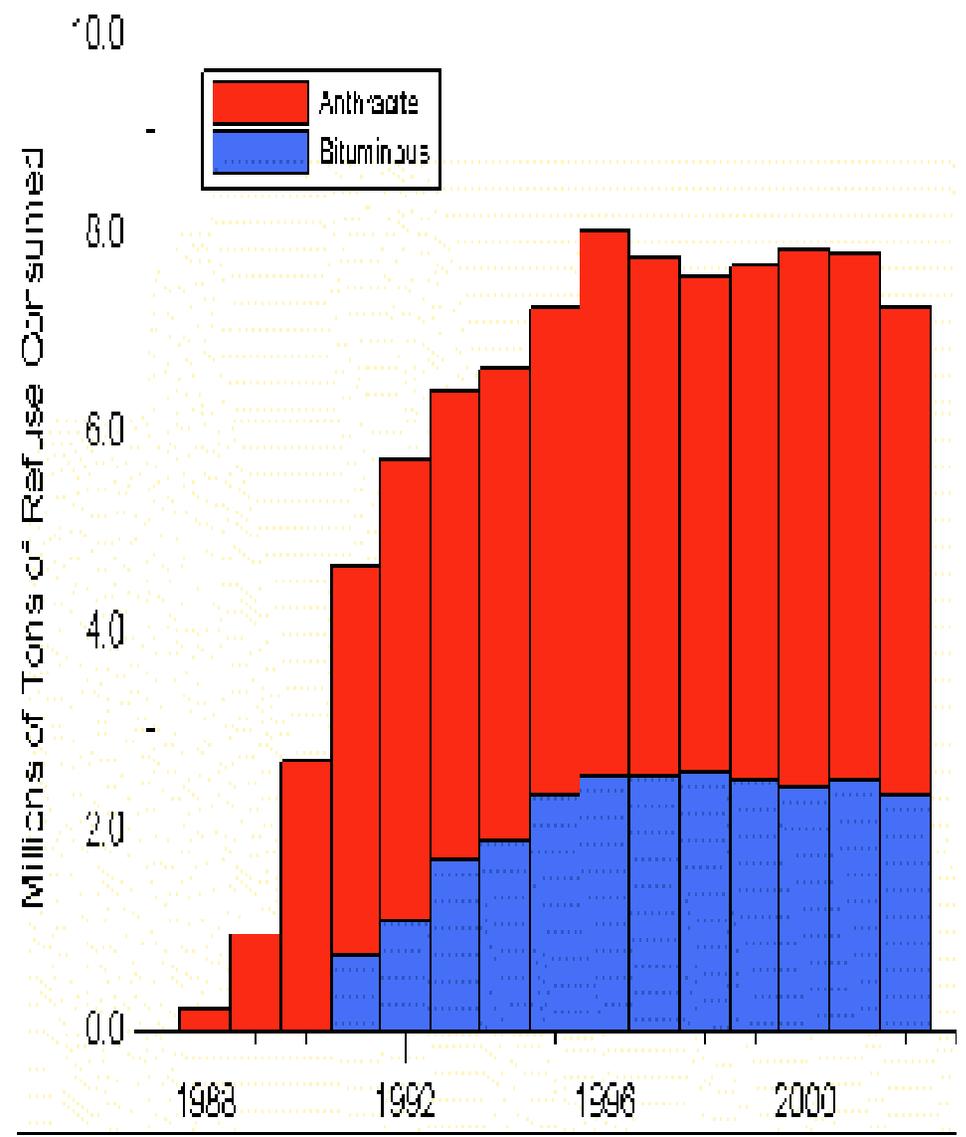
# Economics of Abandoned Mine Reclamation of Culm Banks

- Energy content of Culm material should be greater than 6000 BTU/lb.
- Transportation is a major cost; The closer the distance of pile to plant, the better; Outside limits are about 50 miles
- Higher Culm sulfur content requires more limestone addition and higher costs
- Moisture and clay content of Culm may affect material handling and combustion properties, possibly affecting costs
- The pile site needs to be accessible to trucks and equipment and site characteristics need to be conducive to pile removal and site reclamation
- The ability to haul back CFB ash to the pile site lessens the costs of ash disposal, while providing the benefit of the material
- Price paid to pile owner has to allow for profit by operator
- Open and honest relationships with the general public in the surrounding communities where the reclamation will take place



**Acres reclaimed**

## Refuse Consumed



# Economics of Abandoned Mine Reclamation of Culm Banks

- All the foregoing considerations will contribute to the costs of permitting, material handling, transportation, preparation, and reclamation
- **The bottom line is that it has to make good economic sense in order to remove a pile**
- In some instances, providing a subsidy to the operator may be a way of removing a pile with otherwise marginal economics



# Aerial photo 1998 showing the Revloc sites



# Reclaimed portions of the Revloc 1 refuse site.



# **ARIPPA Plants Speed Up the Reclamation of PA's Abandoned Mine Lands Utilizing Coal-Ash for Beneficial Use**

- CFB boiler technology has made the hope of ridding Pennsylvania's landscape of hundreds of coal refuse piles a reality
- **The environment, the economy, and citizens all benefit from the services Coal Refuse Burning Power Plants...and ARIPPA provides.**

# Renewing the Environment



**The Honorable  
Kathleen A. McGinty Secretary  
PADEP**

- “In addition to the environmental and economic benefits derived from the re-use of waste coal, the Commonwealth's 15 waste coal power plants generate enough electricity to power approximately 1 million homes annually. They do this with relatively low air emissions, adding to the environmental success of cleaning up waste coal piles that cause water and air pollution.”

# Renewing the Environment



Abandoned surface mining pits are filled with coal ash.



Reclamation complete — Environment restored for productive use!

**Mary Jo White, Chairman and Raphael J. Musto, Chairpersons PA Senate Environmental Resources & Energy Committee**

- “These small, independent plants contribute greatly to cleaning up waste coal piles and reducing the threat posed from air and water pollution. Already, Pennsylvania waste coal facilities have removed over 95 million tons of waste coal and reclaimed over 3,500 acres of abandoned mine lands. Additionally, the generating capacity is crucial to meeting the Commonwealth’s energy supply needs. Nearly 2,500 Pennsylvania jobs are either directly or indirectly connected to these plants.”

Philadelphia Inquirer has referred to PennFuture as PA's leading environmental organization

**“PennFuture’s leadership was crucial in creating a new energy law, the Advanced Energy Portfolio Standard, which helps create a market for both renewable energy, and for eliminating the tons of waste coal by using new technology to convert that waste to energy”**

# **Thank-You! Questions? Comments?**



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