



## Overview of West Palm Beach Renewable Energy Facility 2

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# B&W Company Profile



**Headquarters:** Charlotte, NC

**Founded:** 1867

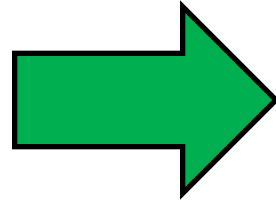
**Employees:** Approximately 4,000 employees, in addition to 250 joint venture employees worldwide

**Web:** [www.babcock.com](http://www.babcock.com)

- ▶ **Global leader in energy and environmental technologies and services for the power and industrial markets**
- ▶ **Installed electricity generation capacity of more than 300,000 MW in more than 90 countries**
- ▶ **More than 500 WTE/biomass units installed worldwide**
- ▶ **Pioneered environmental equipment in the 1970s with most comprehensive suite of products available**
- ▶ **Employees in 25 countries and 6 continents**



# Introduction to Waste to Energy (WTE)

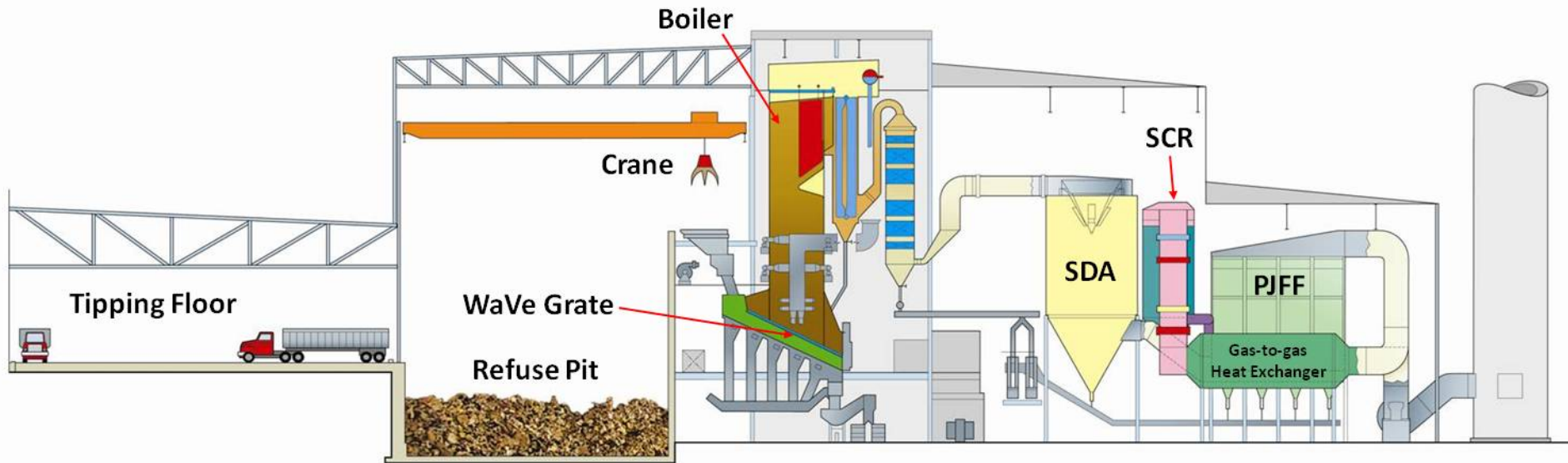


# How Does it Work?

- MSW

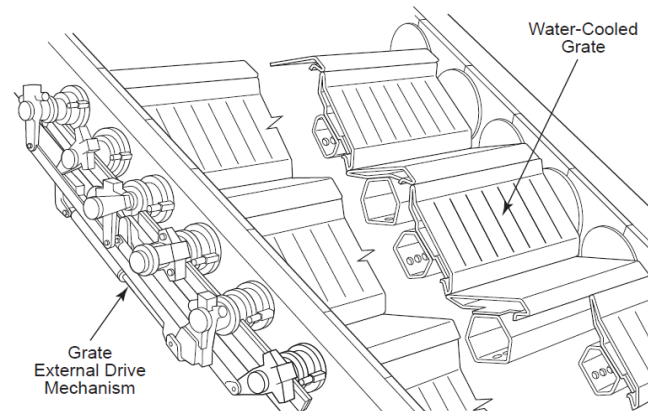
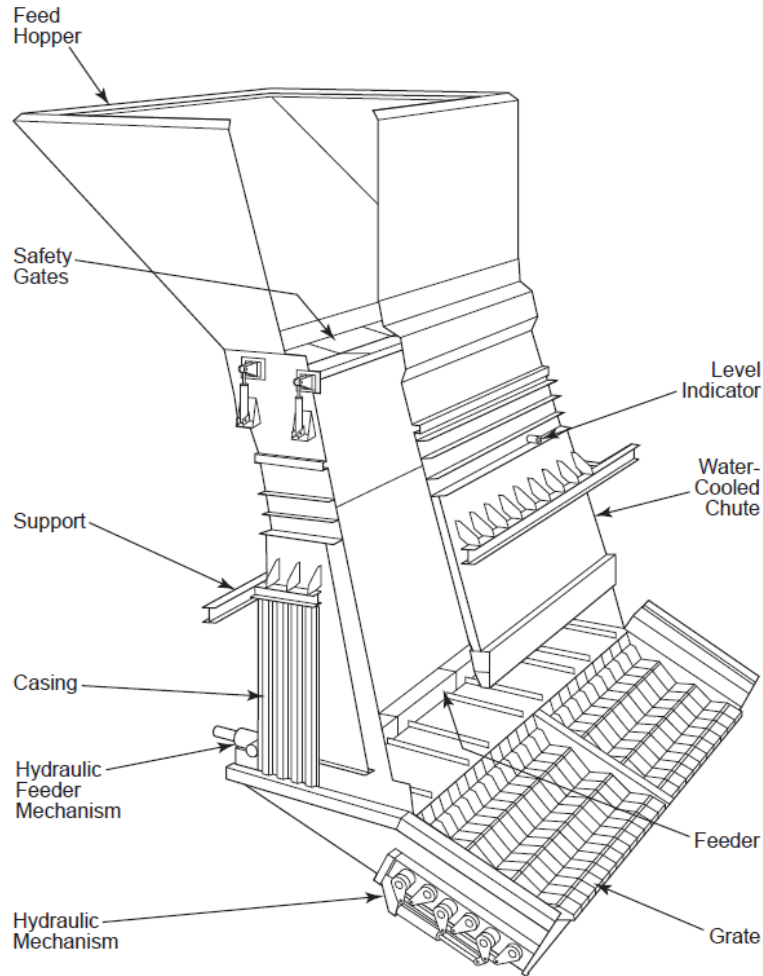


Power Generation



# Combustion System

- **Volund DynaGrate™**



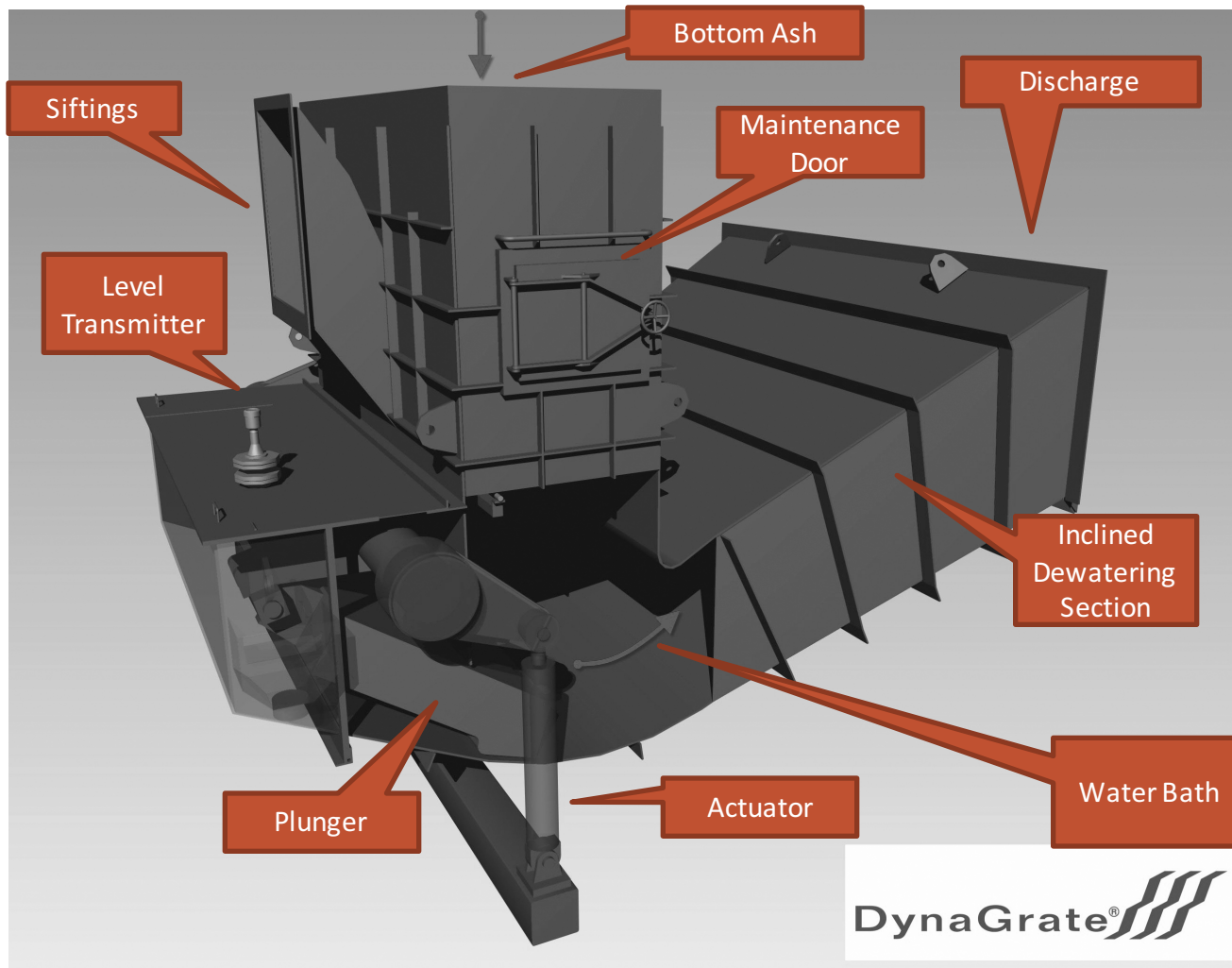
# Combustion System

- Volund DynaGrate™



# Ash Extraction

- Bottom Ash Removal



# Air Quality Control Systems

Combustion of the process waste, no matter how well it is performed, will always produce gaseous emissions.

West Palm Beach successfully integrates the following AQCS scope:

## Powdered Activated Carbon Injection

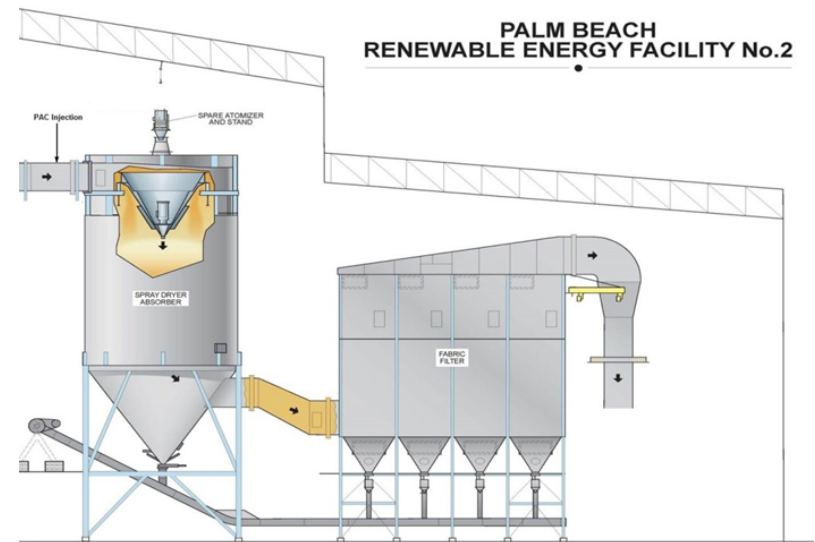
Pneumatically conveys carbon for injection into flue upstream of SDA to control Hg.

## Spray Dryer Absorber

Atomizes lime slurry for removal of acid gases (SO<sub>2</sub>, HCl, and HF control)

## Pulse Jet Fabric Filter

Removes particulate and reaction byproducts of the upstream SDA and PAC system

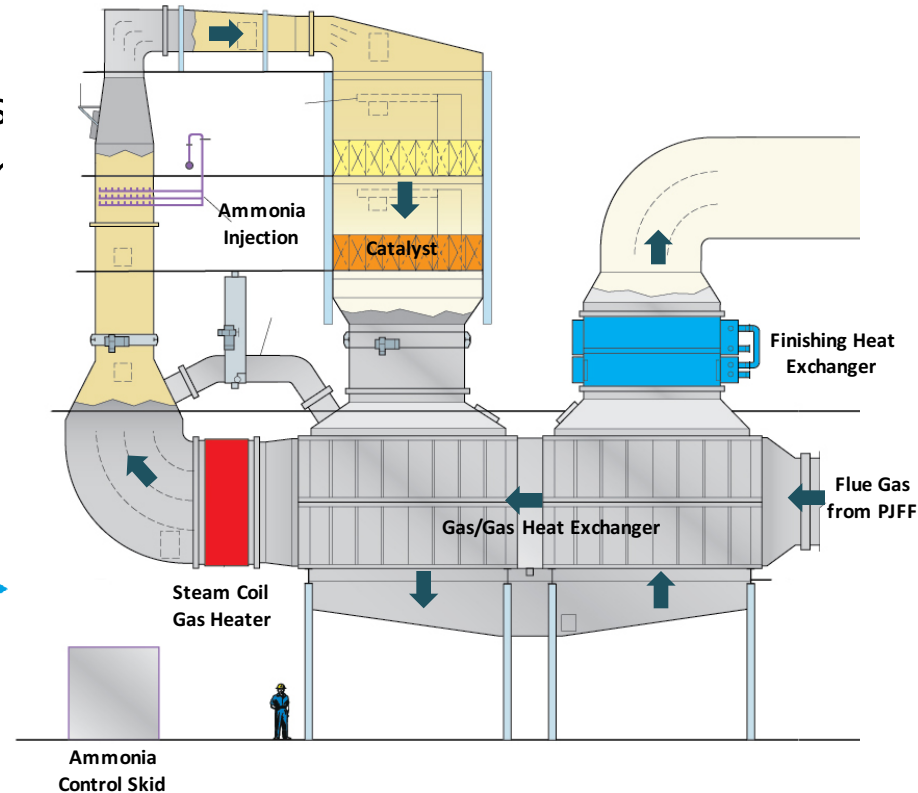
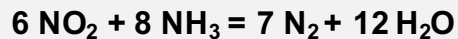
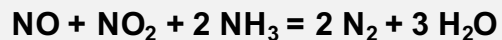
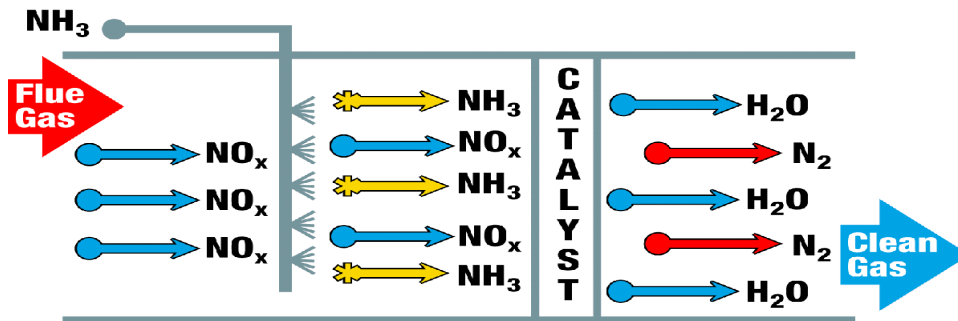




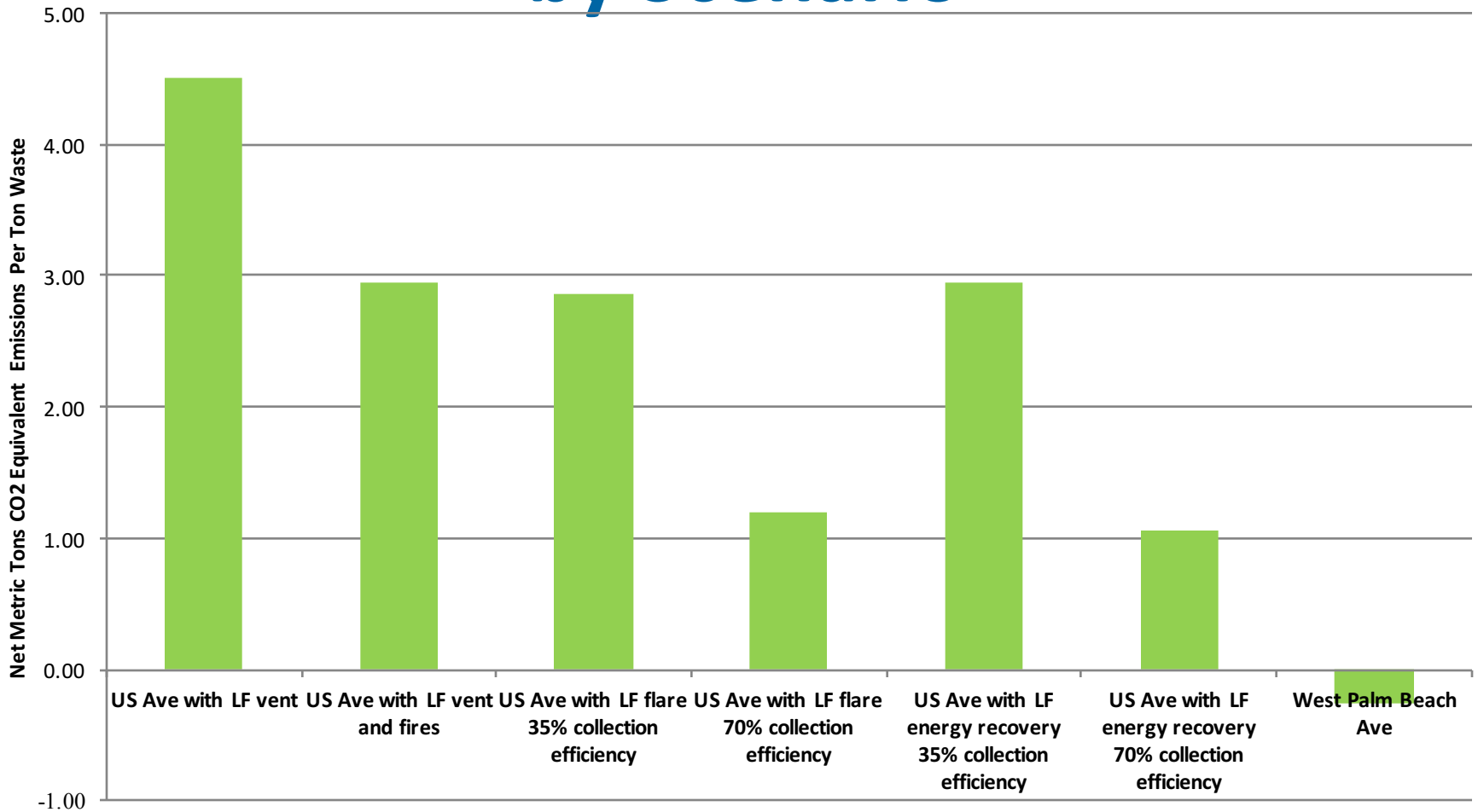
# Air Quality Control Systems (cont)

## Selective Catalytic Reactor

- NO<sub>x</sub> Control (~75% removal)
- WPB was B&W's first WTE project to incorporate an SCR
- B&W developed an innovative flue gas reheating system to ensure the proper temperature to the SCR and avoid catalyst poisoning



# Net Total CO2-eq Emission Results\* by Scenario



\*Note: Using IPCC 5<sup>th</sup> Assessment, 20-year GWP value of 85 for methane.

\*\* RTI US Decision support tool for material and waste management, modeled by Keith Weitz, RTI International



# Net Total CO<sub>2</sub>-eq Emission Results\* by Scenario

## *How are those numbers quantified?*

Waste to Energy plants emit less net CO<sub>2</sub> than fossil fuel plants that use gas, oil, or coal. Here's how...

- MSW is 60% food, agricultural waste, paper, wood, and other biomass
- EPA classifies these as renewable resources that add no net CO<sub>2</sub> to the ecosystem
- Solid waste that is landfilled decomposes and emits methane, a greenhouse gas that is 28 to 36 times more impacting than CO<sub>2</sub>.

*By this accounting, the CO<sub>2</sub> from the facility becomes CO<sub>2</sub> negative.*

# Waste Fuel v. Natural Gas Emissions

Pollutant	Natural Gas Turbine Exhaust	WPB Emissions Permit	WPB Actual Emissions Test
Nitric Oxide	20 - 220 PPM	<50 PPM	30.5 PPM
Nitrogen Dioxide	2 - 20 PPM	Included above	Included above
Carbon Monoxide	5 - 330 PPM	<100 PPM	5 - 24 PPM
Sulfur Dioxide	Trace – 100 PPM	<24 PPM	10 - 21 PPM
Sulfur Trioxide	Trace – 4 PPM	Not required	Not Detectable/Trace
Unburned Hydrocarbons	5 - 300	< 7 PPM	0.2 – 2.7 PPM
Particulate Matter	Trace – 25 PPM	12 MG/DSCM	0.6 – 2.5 MG/DSCM

- \* All Data Shown For Typical Concentration (Parts Per Million Volume) Except Where Noted
- \* Natural Gas Data Source: *Gas Turbine Emissions and Control, GE Power Systems White Paper*
- \* West Palm Beach REF #2 Data Source: Babcock & Wilcox
- \* Actual emission test conducted during compliance test three 4 hr. test per unit – 9 total test with range showing high and low measurement under stable full load testing



# Waste Fuel v. Natural Gas Emissions

Pollutant	WPB Emissions Permit	WPB Actual Emissions Test **
Dioxin/Furan	< 10 ng/dscm	0.23 – 0.36 ng/dscm 0.0073 ng/dscm TEQ++
Trace Metals (Hg)	< 25 µg/dscm	0.55 - 0.62 µg/dscm
Trace Metals (Cd)	< 10 µg/dscm	0.26 - 2.54 µg/dscm
Trace Metals (Pb)	< 125 µg/dscm	0.51 - 8.05 µg/dscm
HCl	< 20 ppm <sub>dv</sub>	1.5 - 2.1 ppm <sub>dv</sub>
HF	No limit set * (<10 ng/DSCM)	0.1 ng/dscm

\* Predicted value < 10ng/dscm - Testing only to verify value

\*\* West Palm Beach REF #2 Data Source: Babcock & Wilcox

\*\* Actual emission test conducted during compliance test three 4 hr. test per unit – 9 total test with range showing high and low measurement under stable full load testing

++ sum of all the TEQ isomers

# West Palm Beach Metals Recovery

## WPB Recycle of metals reduces GHG emissions from fossil fuels

- ▶ 2190 tons/month of post combustion Ferrous metals recovered
  - 56% savings in energy in recycle of Steel vs. virgin ore
  - Each ton of steel recycle saves 1400 lbs of coal and 120 lbs of limestone
  - Yearly savings of 18,400 tons of coal and 1,580 tons of limestone
  - Demonstrated 97.2% ferrous capture rates post combustion
- ▶ 157 tons/month of post combustion Non-Ferrous metals recovered
  - 92% savings in energy in recycle of Aluminum vs. virgin ore
  - Each ton of non-ferrous recycle conserves the energy equivalent to 1234 gallons of gasoline
  - Yearly energy savings of approximately 2.325 million gallons /year
  - Demonstrated 88.6% non ferrous capture rates post combustion

# Achievements – West Palm Beach Renewable Energy Facility 2

- ▶ First WTE plant built in U.S. in 20 years
- ▶ Most-advanced WTE plant in North America
- ▶ 28,000 tons of additional metal recovered annually
- ▶ Reduced volume sent to landfill by 90%
- ▶ Better than zero discharge on water
- ▶ Key part of county's overall recycling, composting and clean energy program
- ▶ On-site electric vehicle charging
- ▶ LEED certified visitors center for community education
- ▶ Asset to the community
  - Generates electricity for 40,000+ homes
  - Generated over 1,000 design, manufacturing and construction jobs
  - Operated by more than 70 full-time, highly skilled workers



# Achievements – West Palm Beach Renewable Energy Facility 2

## Ultra-low emissions well-below permitted levels

- Lead, mercury, dioxin/furans, hydrochloric acid, VOCs
- Sulfur dioxide, nitrogen oxides, carbon monoxide, particulate, sulfuric acid
- Landfill methane eliminated
- Lower net CO<sub>2</sub> emissions than coal, oil or natural gas
- Net negative GHG profile (CO<sub>2</sub>, methane)
- *Lowest emissions of any WTE plant in the world*





# Tangible Economics - West Palm Beach Renewable Energy Facility 2

- ▶ Cost of the plant was \$674 million, or \$224,700 per ton of daily capacity.
- ▶ Processes waste for about \$25/ton, about the same cost as burying the waste in the West Palm Beach landfill.
- ▶ Capable of generating 625 kWh per ton of waste



# General Benefits of Waste-to-Energy

- **Revenues**

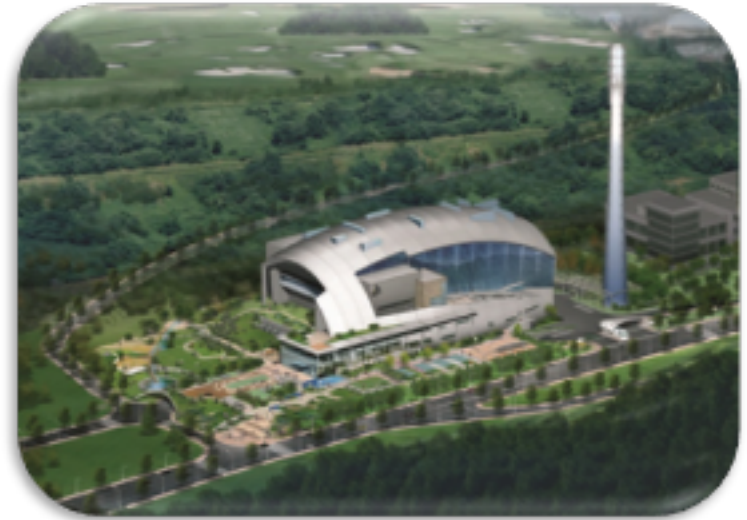
- Metals recovery/recycling
- Tipping fees
- Steam/hot water
- Electricity
- Beneficial use of ash

- **Environmental**

- Low emissions
- Lower CO<sub>2</sub> emissions than coal, oil, and natural gas
- Elimination of landfill methane
- Overall net-negative GHG
- Lower air and water emissions and runoff from landfills

- **Other**

- *Power...on demand when you need it!*





***Q: Which renewable technology can provide clean, always available, on demand power to all these people?***

***A: Windmills***

***B: Solar Panels***

***C: Waste to Energy***

# Questions?

