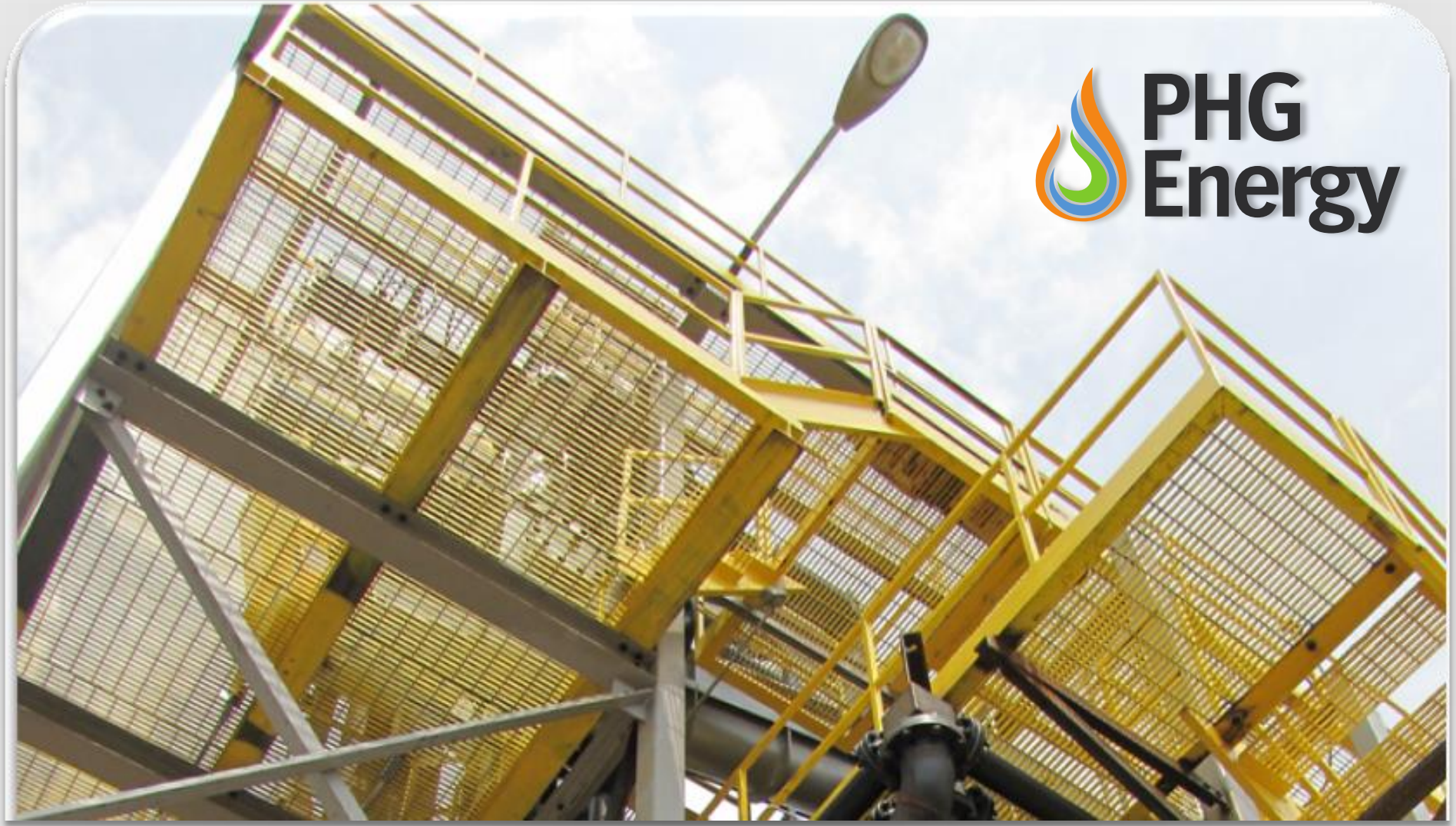


Chris Koczaja
Chief Operating Officer

Who is PHG Energy?

Thompson CAT

Thompson Machinery's outstanding 65-year history of providing equipment solutions to the construction, power generation, forestry and agricultural industries through engineering and product support excellence.

PHG Energy

Nashville based PHG Energy provides R&D, manufacturing, design, installation and ongoing operation and management for gasification systems.

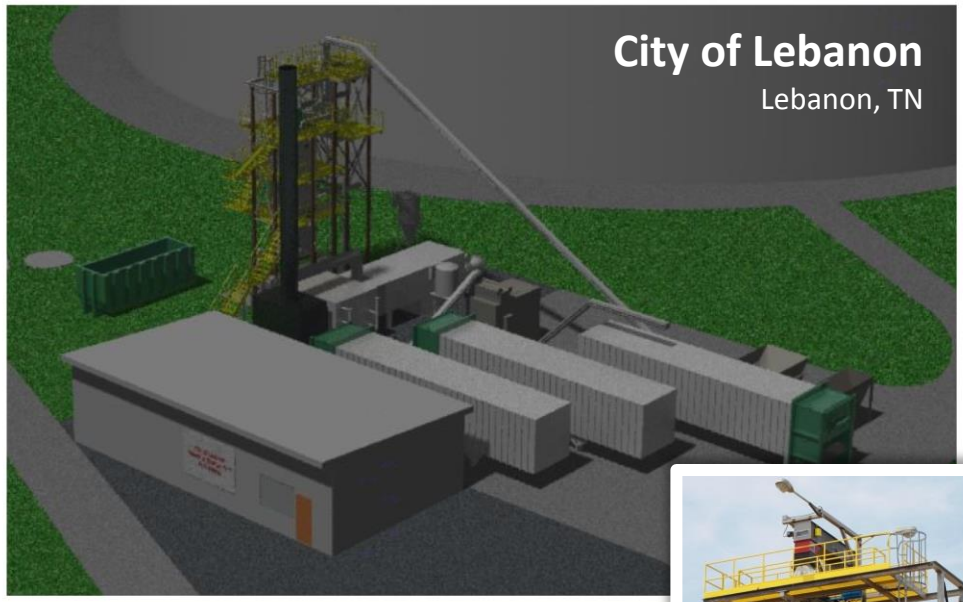
APA

Associated Physics of America's breakthrough and proprietary downdraft gasification technology resulting from years of pure scientific research, proven through extensive equipment utilization in commercial industrial applications.

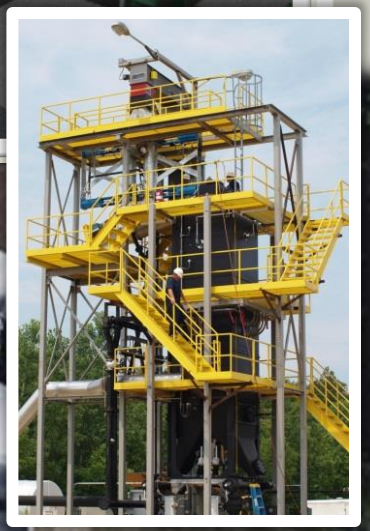

Clean Energy
Carbon Emissions
Crop Residues
Clean Energy Conversion
Through Gasification
New Landfills
Transportation Costs
Sludge Disposal
Tipping Fees
PHG Energy

PHG Energy Waste to Energy Projects

City of Covington
Covington, TN



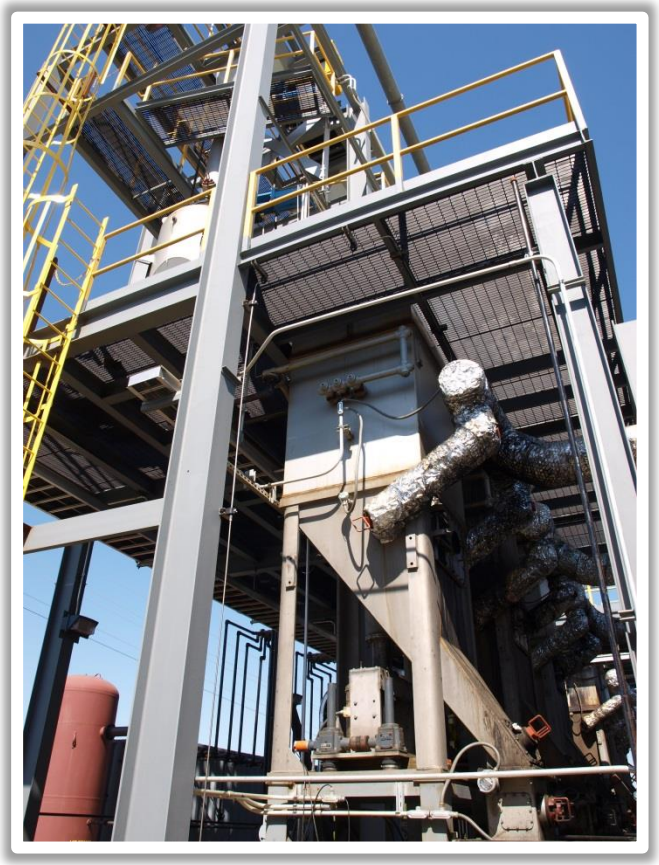
City of Lebanon
Lebanon, TN



Sevier Solid Waste Inc.
Pigeon Forge, TN

What is Gasification?

The clean, efficient <u>conversion</u> of biomass into a combustible fuel gas in an <u>oxygen-starved</u> environment



- A thermo-chemical process to produce a clean fuel gas. **This is *<u>NOT</u> Incineration***.
- Feedstock flexible of the life of the equipment
- Can retain and retrofit current equipment to use the gas (boilers, kilns, etc.)
- On demand energy generation
- About 95% of what goes in comes out as fuel gas. The other 5% is a charcoal biochar with many uses.
- Can be adapted for future applications

PHG Energy

What Can You "Gasify?"

- Woodchips
  - Utility trimmings
  - Scrap pallets/Construction
  - Bark or waste wood
  - Commercial waste
- Agricultural and animal waste
- Scrap tires and rubber products
- Food processing and other manufacturing waste
- Switchgrass, miscanthus and other purpose-grown energy crops
- Mixtures improve performance



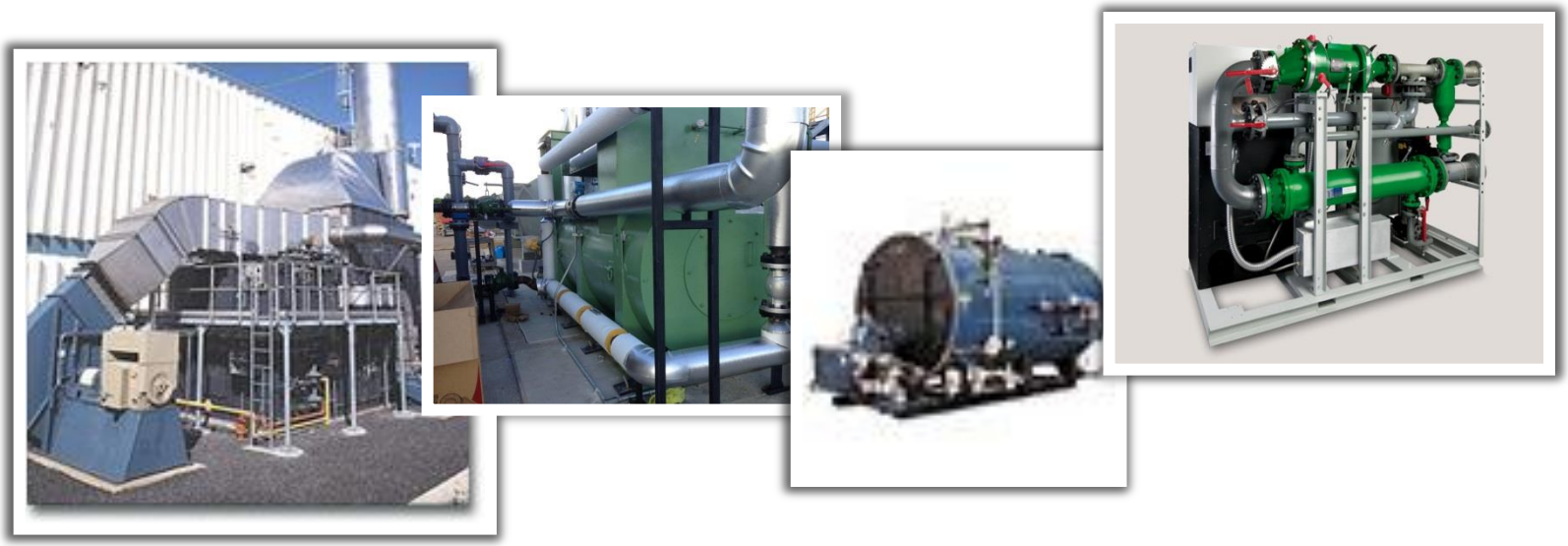


PHG Energy

Using The Fuel Gas:

Currently Being Utilized Here and Worldwide

- **Electricity: Gas or steam turbines and ORC generators**
- **Steam: Boiler and community heating systems**
- **Direct Thermal: Kiln Operations & Sludge Dryers**
- **Combustion: Industrial thermal oxidizers**



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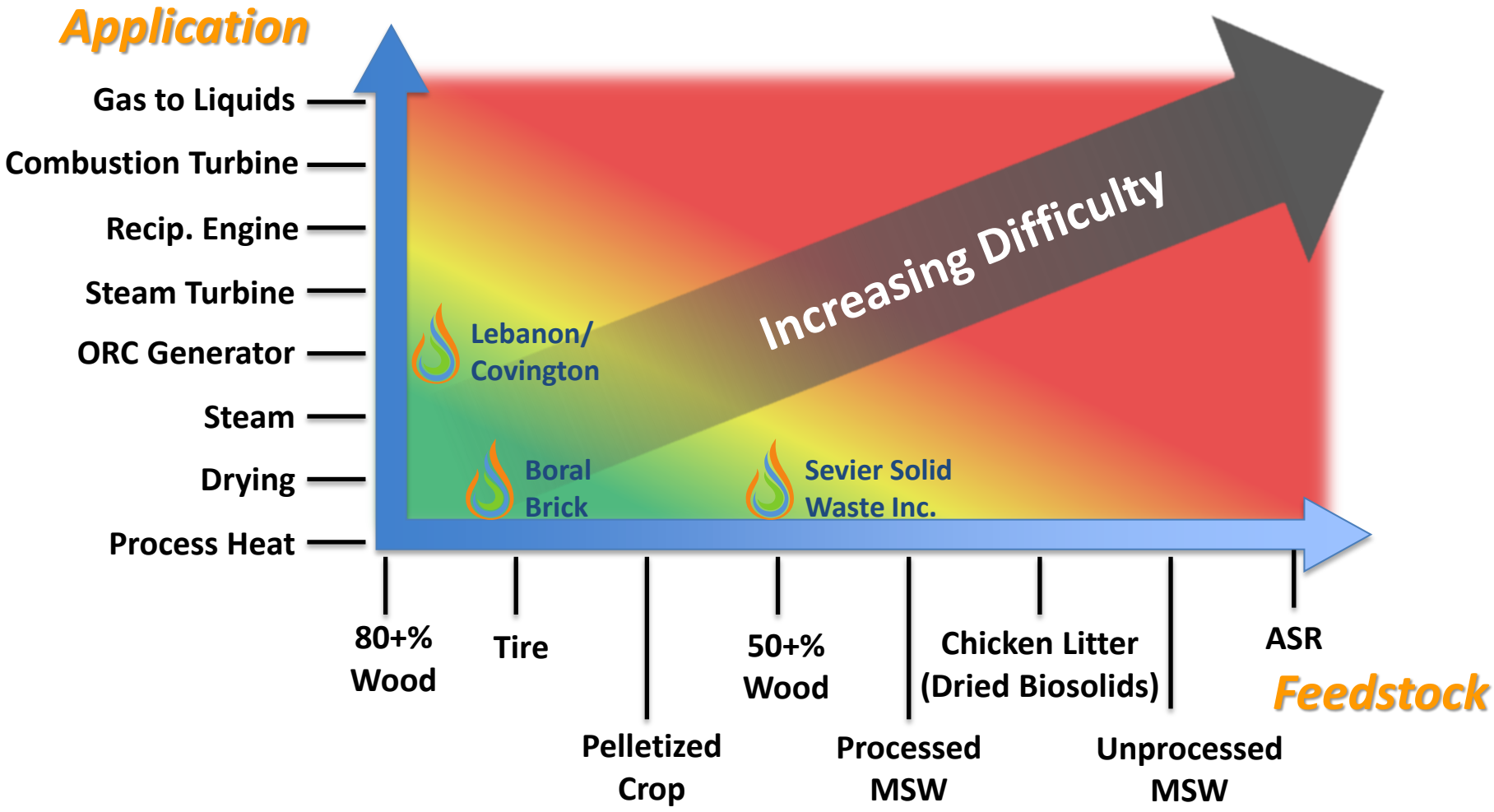
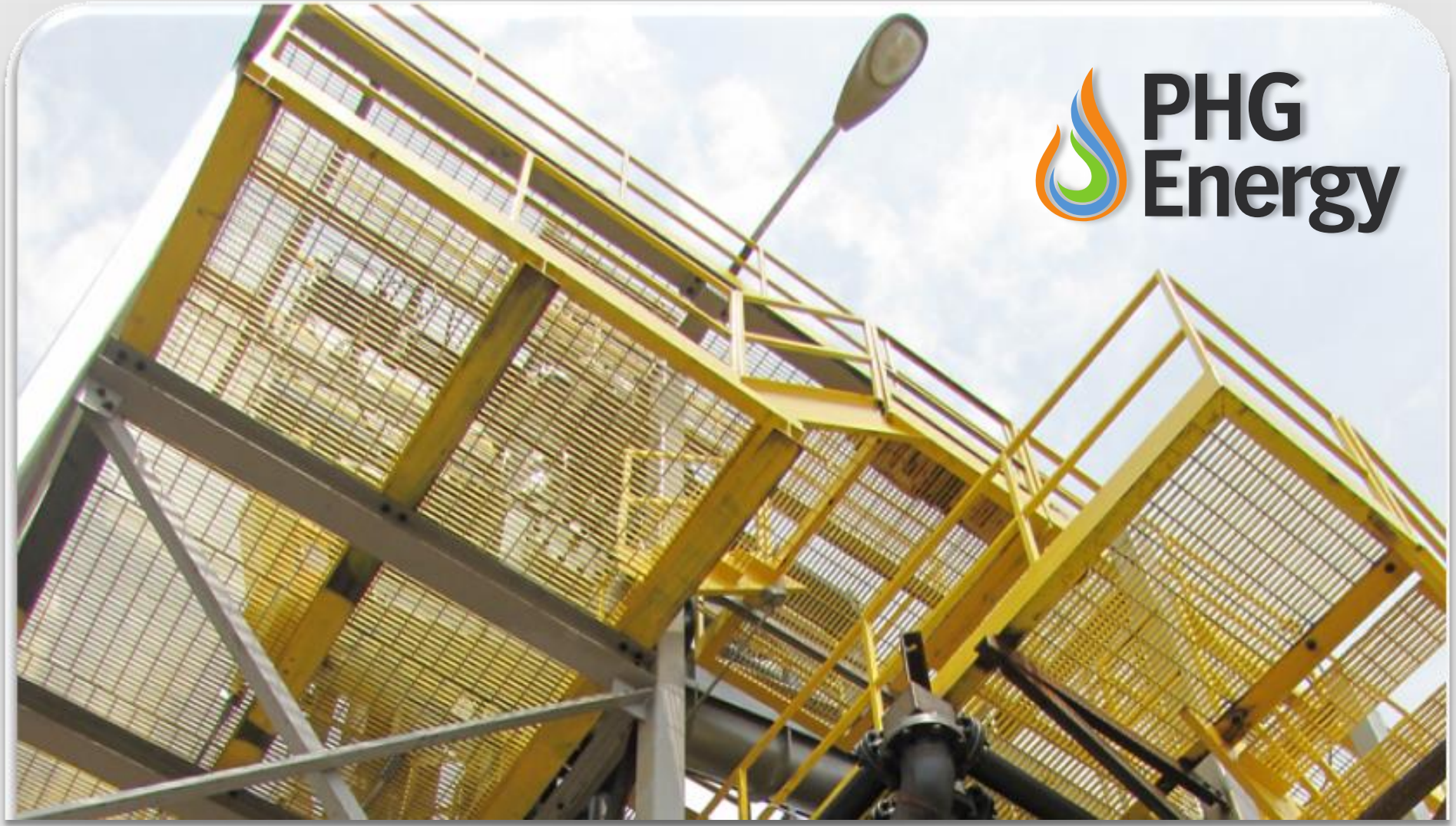
Project = Feedstock + Application
DRIVING vs. DRIVEN Variables



PHG Energy



Waste To Energy Project Development

A Municipal Vision Taking Shape Now

Municipal Garbage

Municipal Waste Sorter

Heat and/or electricity for the process

Output Options
- Electricity
- Class A biosolids

Plastics | Glass | Metals

Sorter Removes Recyclables

Pellets Out of Sorter & Into Gasifier

Pellets

Wood Waste

TIRES
SLUDGE
CROPS
?

Other Waste Streams

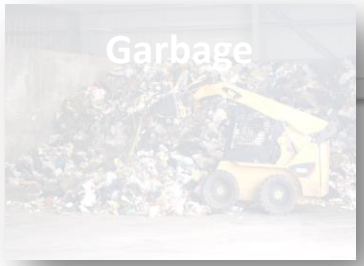
Application options:
- ❑ Power Generation
- ❑ Sewer Plant Sludge Drying
- ❑ Combined Heat and Power
- ❑ ??

Heat Energy

→ Provide key infrastructure to reduce disposal cost risk and volatility

PHG Energy

Phase Approach: Use Existing Waste Streams



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- ❑ ??

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→PHASE 1: Start with what can be easily handled today

Feedstock logistics are **KEY**

Start with a wood base and mix other feedstock in

Green Energy

Material Collection, Preparation, and Transport

Biochar

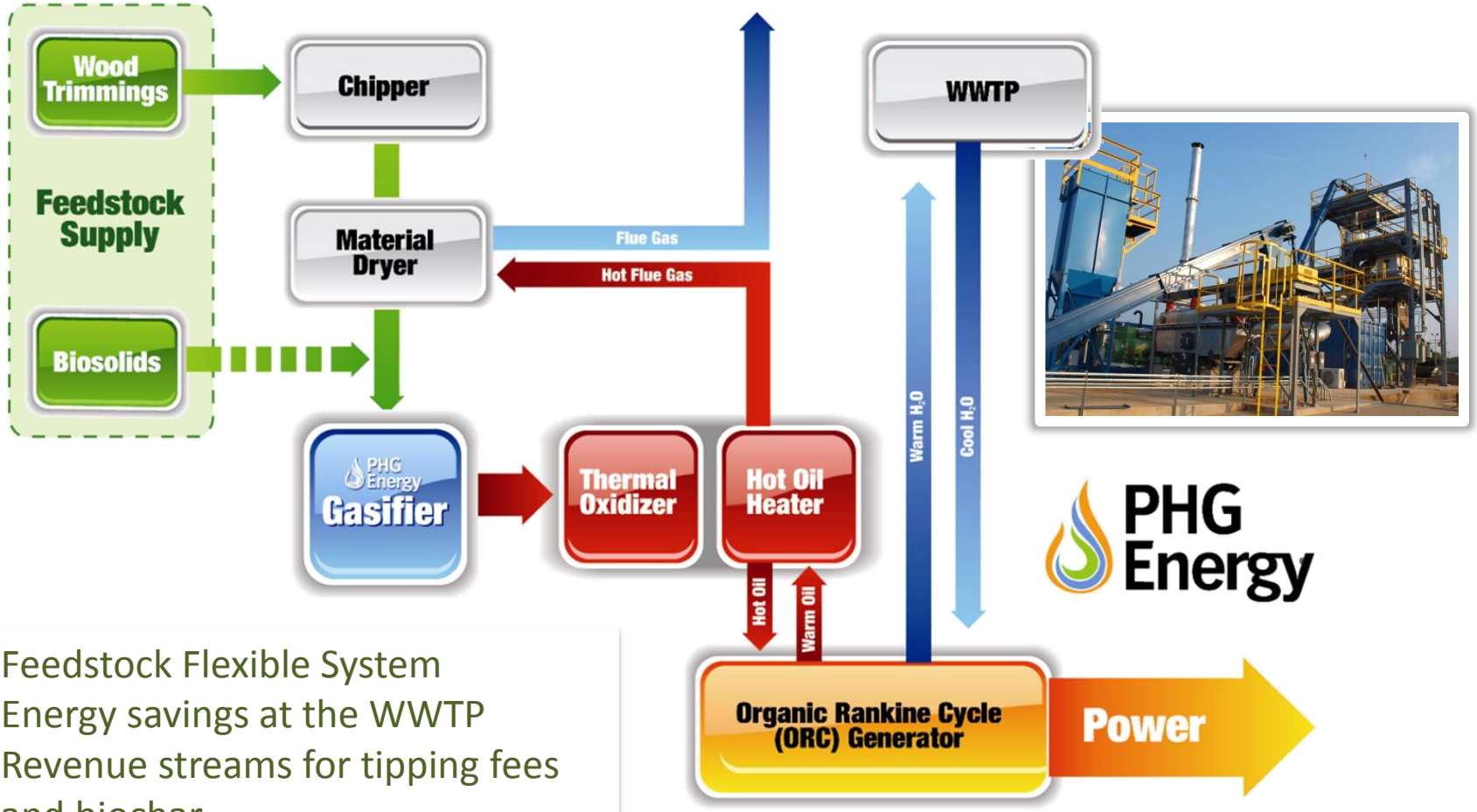
Tipping Fees

Biochar Sale

PHG Energy

Real World Projects

Covington and Lebanon, TN Waste-To-Electricity System



- Feedstock Flexible System
- Energy savings at the WWTP
- Revenue streams for tipping fees and biochar
- Deferred waste disposal costs

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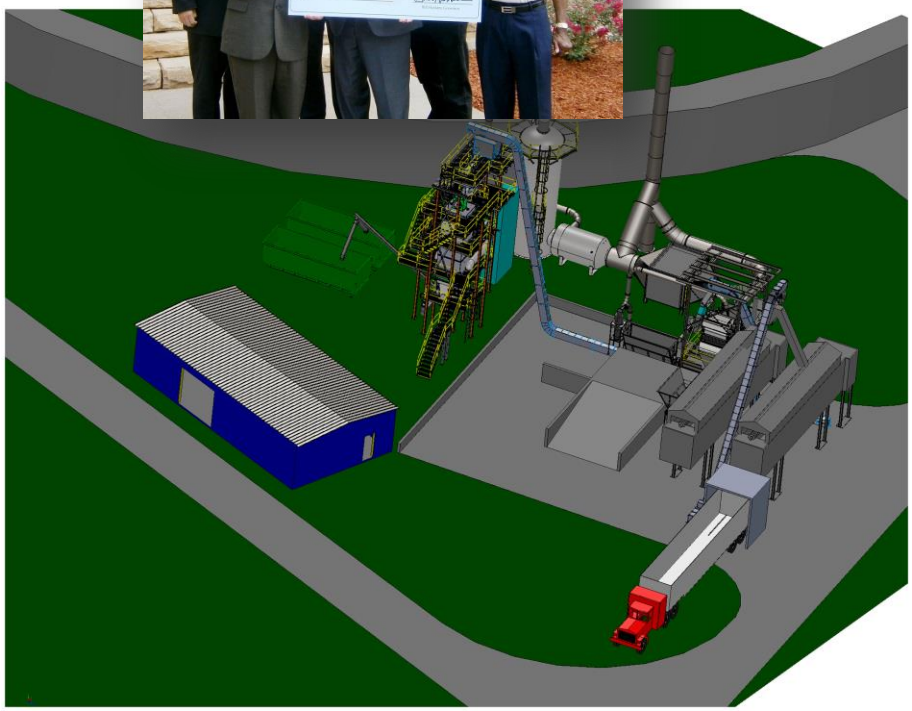
Lebanon, TN Waste to Energy

Known Operating Elements:

- 32 TPD material processed (Expandable to 64TPD)
- 3 tons sludge, 3 tons tires, 26 tons wood waste
- Operating 24/5/52 or 6240/year

Variable Income Elements and <u>Cash Flow Drivers</u>:

- Tipping fee income to City from Industry and/or Wilson County
- Material hauling and pre-processing costs
- Taking existing ATAD offline and processing sludge in gasifier



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System for Sevier Solid Waste

Wood

Compost

Gasifier

Biochar

Gas

Gas Combustion / Thermal Odor Control

Clean Exhaust

ODOR FROM OPERATIONS

Also a CTEG grantee!

Keys to a Successful Project

Gaining understanding of the waste and energy infrastructure needs and support for a new approach to both

- FEEDSTOCK VS. APPLICATION
  - Tipping fees and hauling costs
  - Outlet for the energy: heat or electricity or both
  - Deferred capital expenditures
  - Biochar market
- KEY CONSIDERATIONS
  - Understanding feedstock preparation and logistics
  - Managing project complexity
  - Change management
  - Work WITH regulators to resolve new issues

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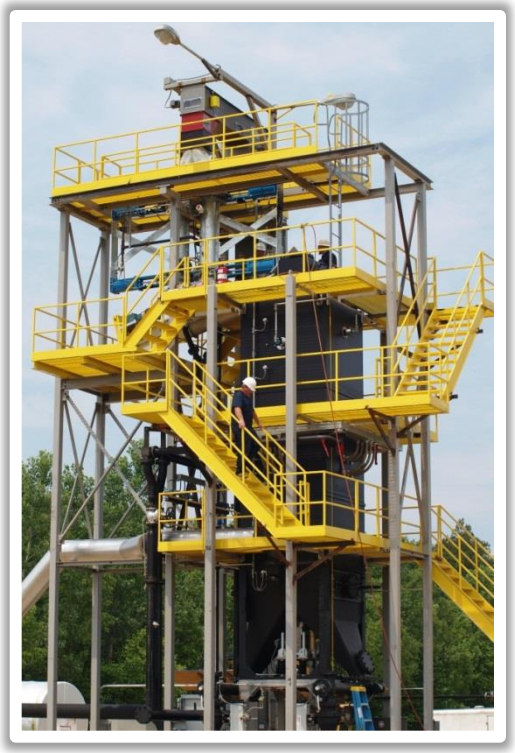
Questions?



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