



Covanta R&D

Developments in

MSW Gasification Technology

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Agenda

1. Gasification and MSW
2. Commercial Gasifier Demonstration
3. **COVANTA CLEERGAS™** System
4. Covanta Future Gasification R&D



Gasification

Gasification is the partial oxidation of the organic content of a feedstock to produce a H₂ / CO containing syngas

PYROLYSIS

H_Cs, Tars, Char

$$\lambda = 0$$

(No air)

Very Endothermic

GASIFICATION

H₂ / CO

$$\lambda < 1$$

(Partial air)

**Exothermic/Endothermic
Balance**

COMBUSTION

CO₂, H₂O

$$\lambda > 1$$

(Excess air)

Very Exothermic

- Gasification is a well established process for fossil fuel and biomass feedstocks – but economics are still challenging
- Gasification process is very sensitive to the feedstock



Challenges With MSW

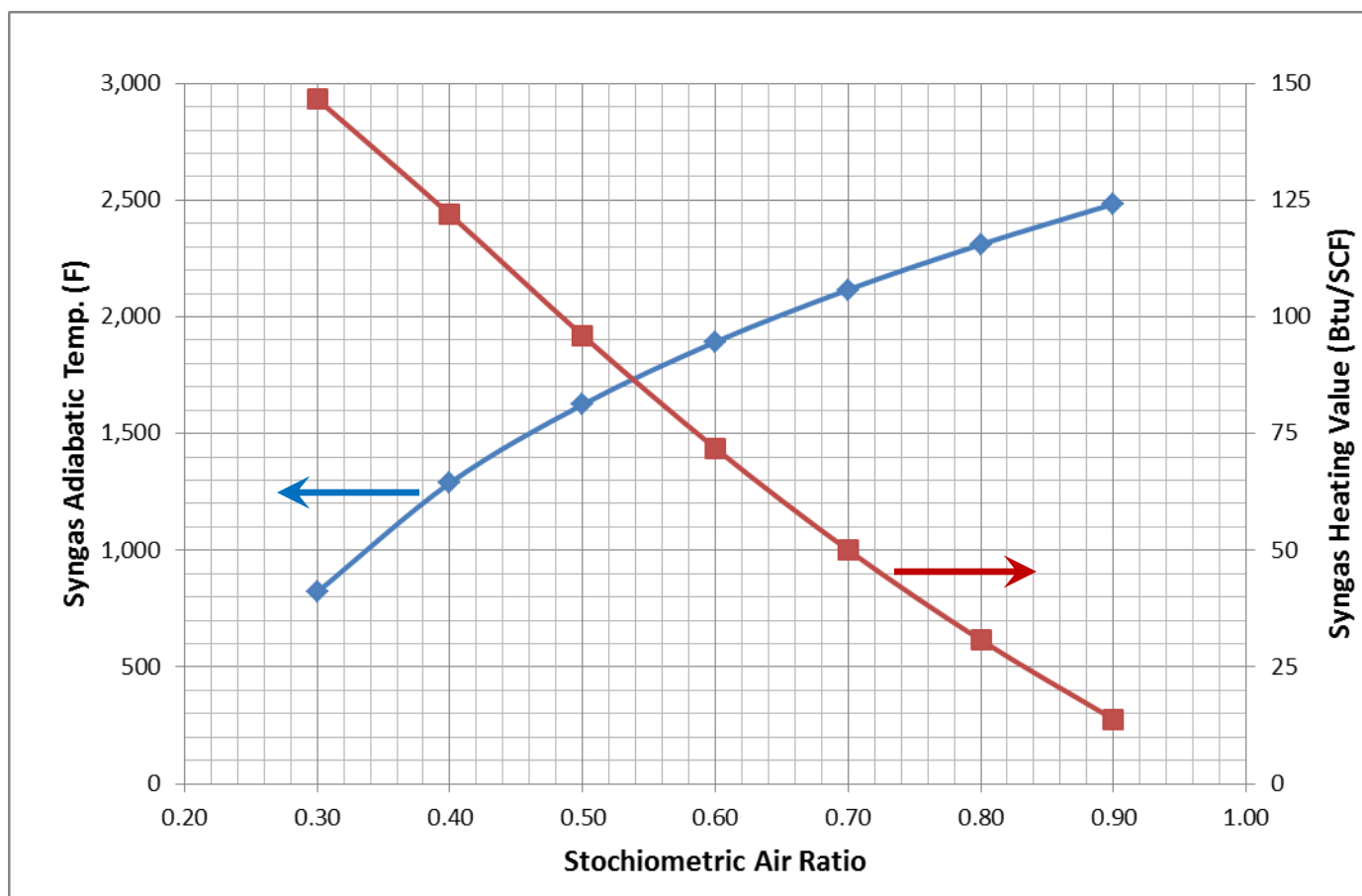
Gasification of MSW is technically and economically challenging

- **Heterogeneous nature of MSW complicates equipment design, process design and process control**
 - Broad range of physical and chemical properties
 - Heating value variability
- **Gasification processes developed for coal or biomass would require significant pre-processing of MSW**
 - Moving bed, fluidized bed, entrained flow reactor types
- **Syngas heating value and purity dependent on many parameters**
 - Gasification temperature, air or oxygen, other reactants (steam, CO₂), other energy inputs (plasma), gasifier design, control system



Gasification

Heat Balance Considerations





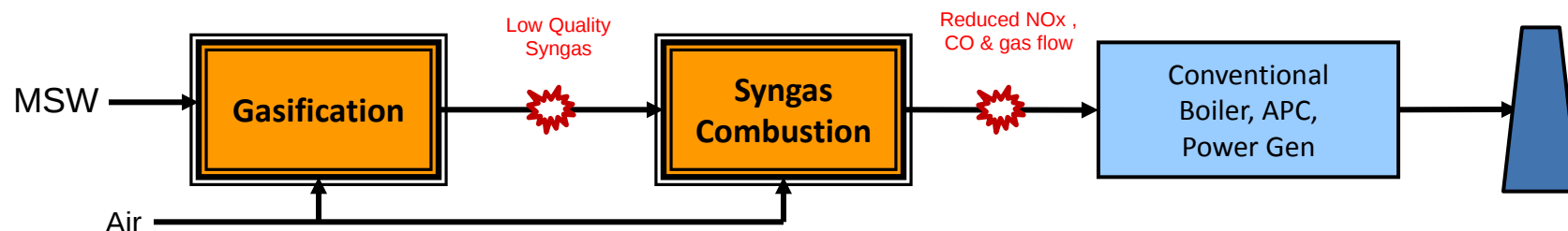
Covanta Approach – MSW Gasification

- System designed for unprocessed, post-recycling MSW
 - Handling, shredding, processing, storing waste is expensive – especially high operations & maintenance costs
- Employ reliable solid handling equipment for feeding, gasifying, and ash removal
 - Analogous to mass-burn
- No additional sources of energy input to the process
 - Power, plasma, coal or coke
- Air based – no oxygen enrichment
 - Oxygen aids process, but cost is not recovered in product value
- Commercialize MSW gasification with syngas combustion
 - Lower excess air = smaller equipment, higher energy and lower emissions
 - Improved control of NO_x and CO

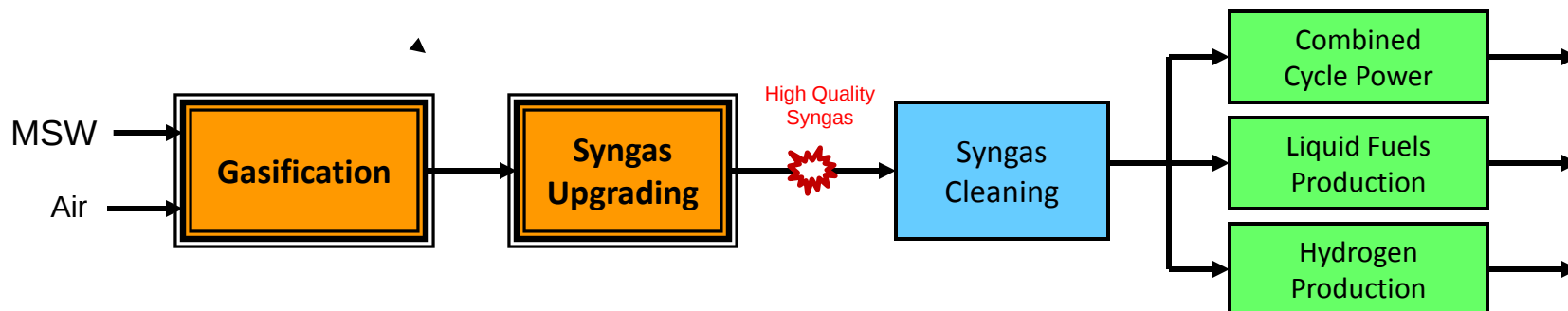


Types of MSW Gasification Processes

GASIFICATION/SYNGAS COMBUSTION - Goal of Improved Emissions, Higher Energy Efficiency, Smaller Equipment
Commercial CLEERGAS System



GASIFICATION / SYNGAS RECOVERY - Goal of Combined-Cycle Power or High Value End-Products
Ongoing Covanta R&D

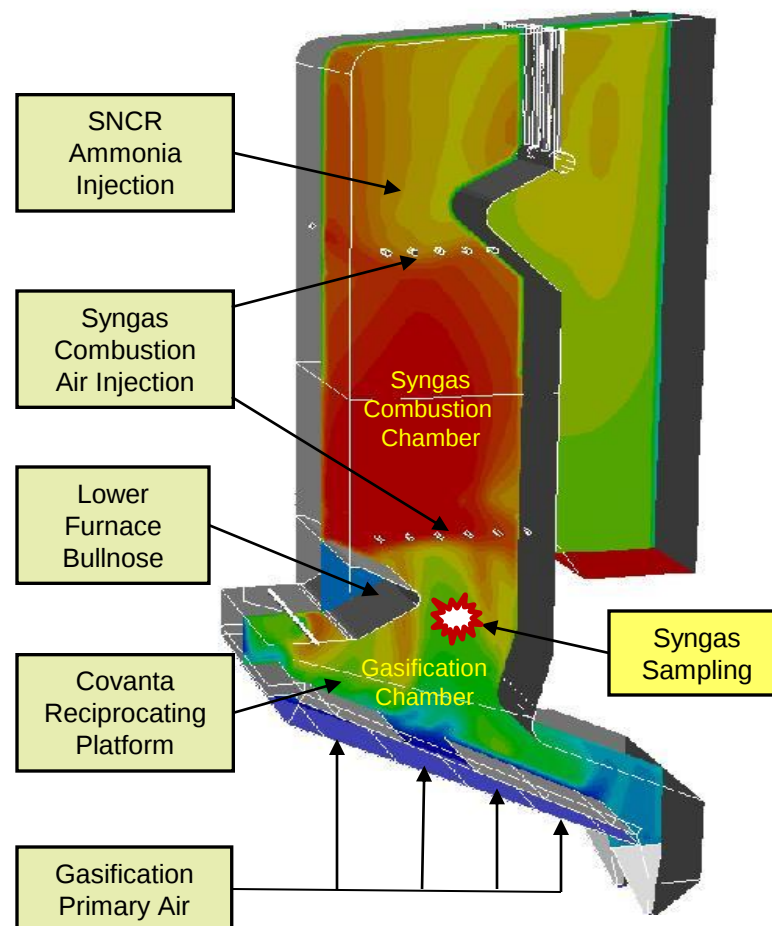




Commercial Gasification Demonstration Tulsa Unit 3

MSW Gasification with Syngas Combustion

- Covanta designed reciprocating platform, feed system and ash discharger
- Conventional feed system - no MSW preprocessing
- Separation of gasification and syngas combustion chambers via addition of lower furnace bullnose
- Four levels of air injection to control gasification and syngas combustion
 - Independent flow measurement and control of air to each primary, secondary and syngas combustor zone
- SNCR aqueous ammonia injection above syngas combustion zone
- Covanta designed control system – superior system stability



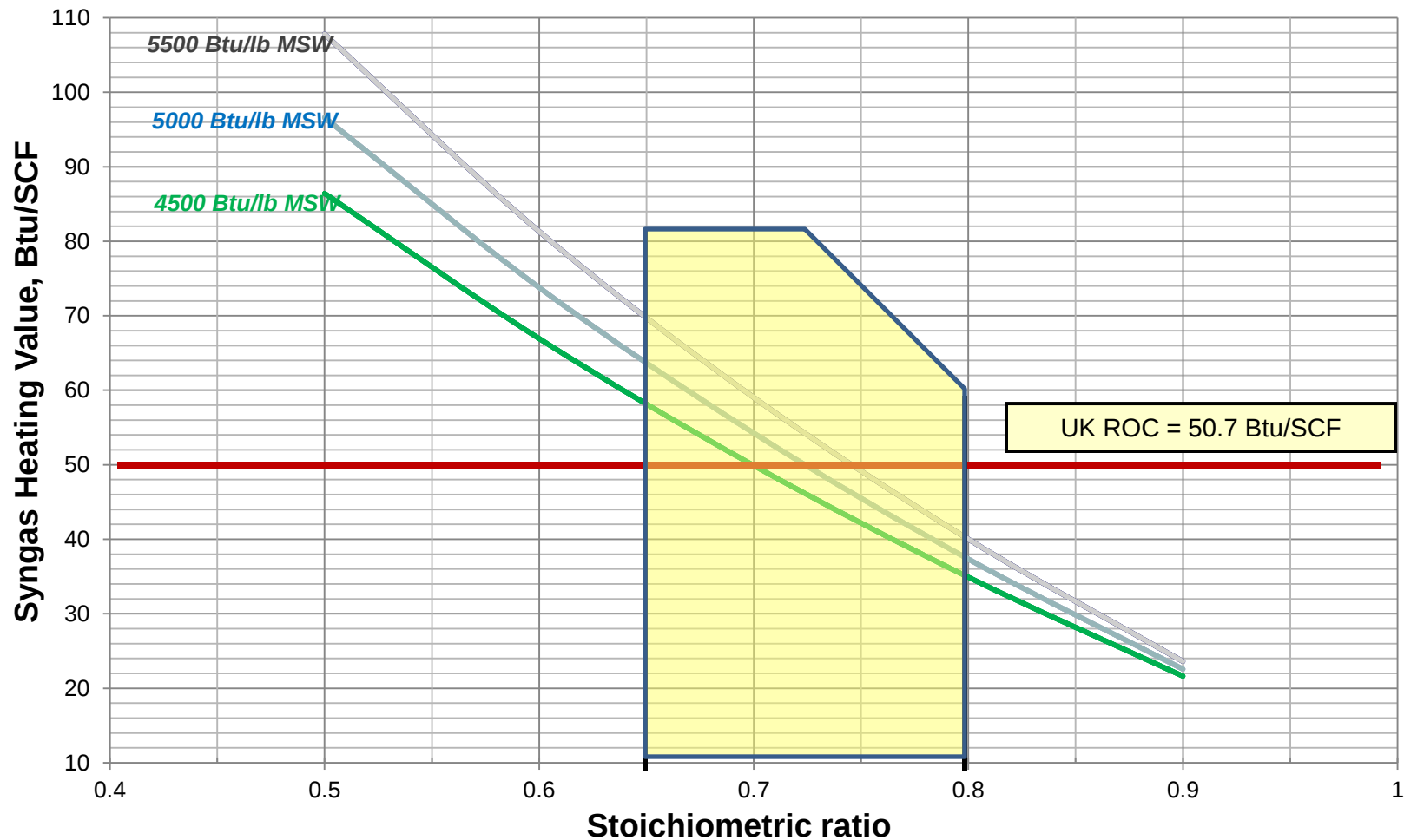


Commercial Gasification Demonstration Tulsa Unit 3 Performance

- Start-up in April 2012
- Operating reliably since July 2011 with **94%** availability
- Excellent emissions performance
 - NOx averaging 40 – 60 ppm
 - Short-term NOx tests < 30 ppm
 - CO held at typical low levels of ~ 20 ppm
 - Other pollutants primarily a function of emission control performance
- Reduced particulate carryover into boiler
 - Reduced fouling – boiler cleaning cost savings
 - Corrosion benefits being evaluated

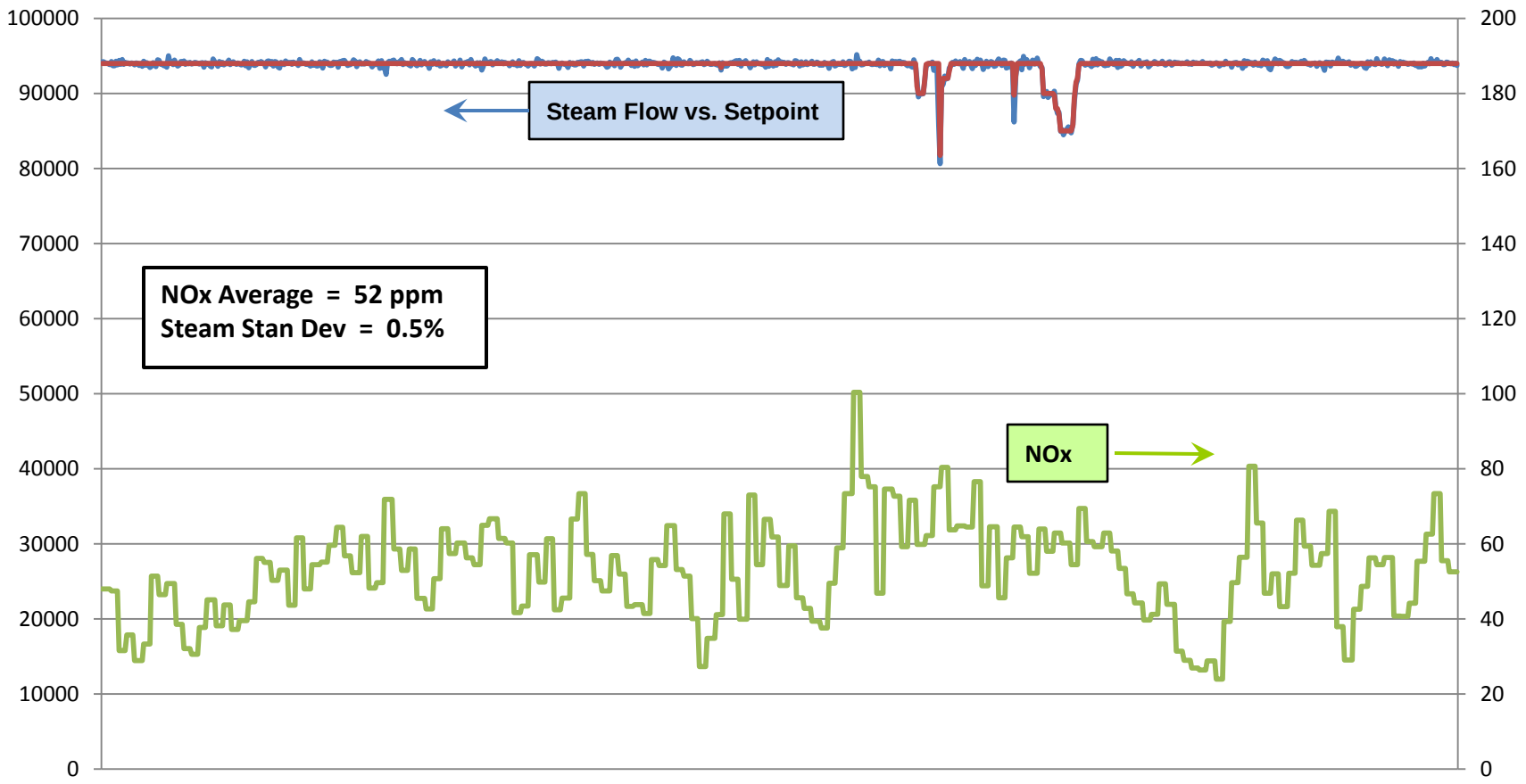


Syngas Sampling and Analysis





Tulsa Demonstration – Gasification Control System

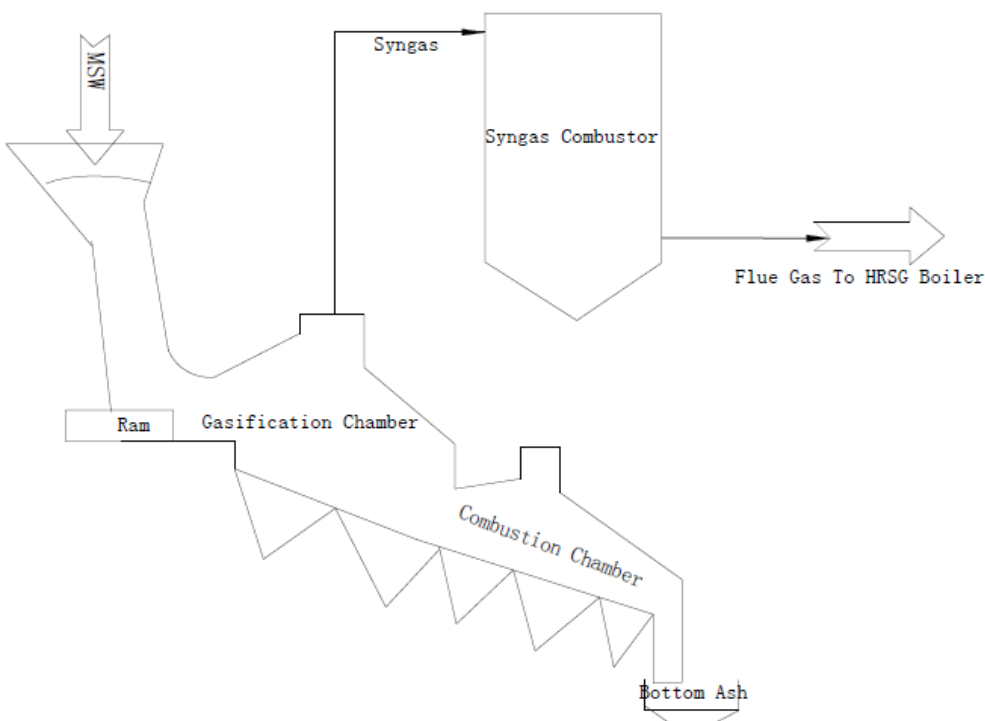


Week Trend from 10/3 thru 10/10



CLEERGAS™ Gasification Process

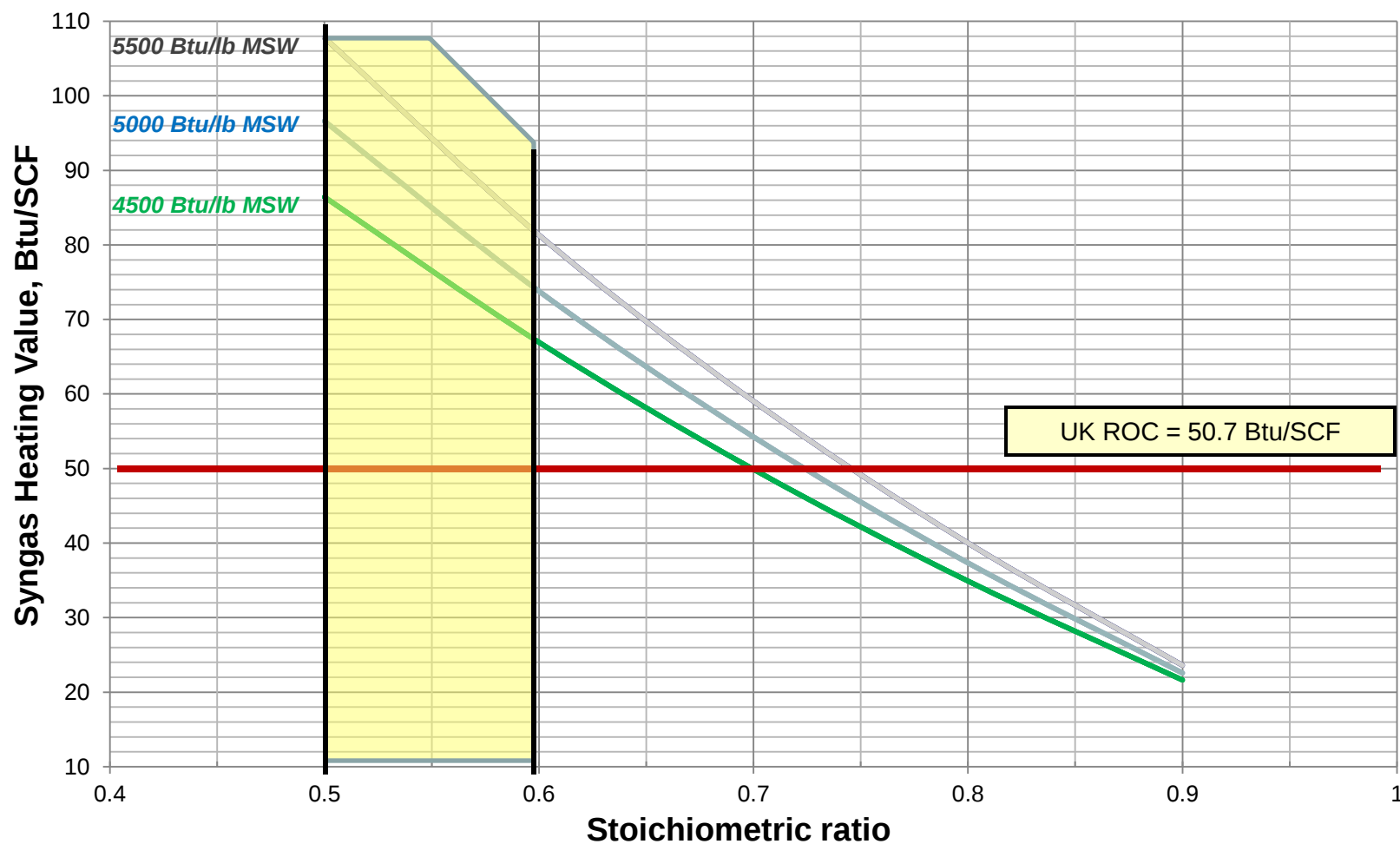
Process improvements from Tulsa demonstration



- Separation of gasification zone from carbon burnout zone
- Burnout zone energy recovered to drive gasification process – reduced stoichiometric ratio and increased syngas heating value
- Refractory-lined gasifier to minimize energy loss – simpler design than waterwall furnace
- Cylindrical waterwall syngas combustor with staged air injection – reduces air requirement and NOx formation
- Optimal SNCR performance in turbulent syngas combustor
- Advanced control system built from Tulsa demonstration



CLEERGAS – Higher Syngas Quality





Covanta Low Emissions Energy Recovery Gasification

COVANTA CLEERGAS™

300 TPD Modular Gasification Plant

Covanta designed and guaranteed – based on extensive EfW experience

- Modular design and fabrication to reduce field construction and capital cost
- Advanced control and monitoring system for stable and reliable operating performance
- Performance advantages vs. conventional EfW:
 - Better control of syngas combustion – lower NOx and CO generation
 - Lower air requirement – lower flue gas flow, higher boiler efficiency, lower particulate, smaller equipment

High market interest in commercially viable MSW gasification system

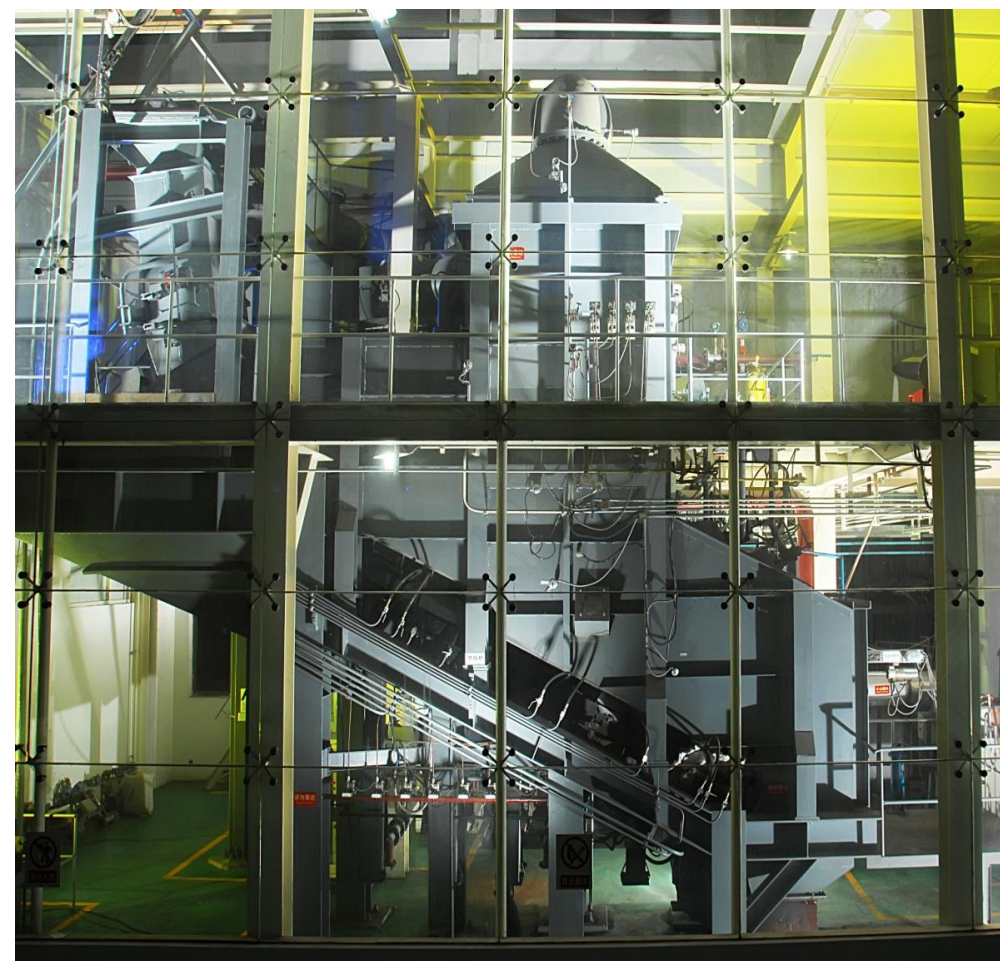
- Responding to multiple procurements for new and emerging technology
 - Both municipal and industrial
- Selected by St. Lucie County, FL
 - 2 x 300 TPD units
 - Combined heat and power



R&D Continues on Syngas Recovery

Goal to produce a clean renewable gas – environmentally equivalent to natural gas

- Evaluating and testing methods to upgrade syngas quality to convert residual tars
- Engineering on technologies to clean-up syngas
- Evaluating advancements in gas engine and gas turbine equipment for firing clean syngas
- **Expanding pilot plant resources**





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ENERGY
for a cleaner world

COVANTA CLEERGAS™

Thank You !