Allothermal Gasification for Indirect Co-Firing

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Allothermal Gasification for Indirect Co-Firing

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Bram van der Drift and Bert Rietveld

CONTENT

- Gasification
- Allothermal gasification
- ECN's MILENA technology
- Comparing CFB with allothermal
  - Efficiency
  - Ash components
- Conclusions

GASIFICATION

Gasification of Biomass

- Gasification converts solid fuel to gaseous fuel
- Opens the door to the existing energy system:
  - Green Power and Heat
    - Boilers
    - Gas engines and gas turbines
  - Green methane
  - Green liquid fuels
  - Green chemistry

Gasification

matching energy consumption and production

energy production - combustion

fuel + air ($\lambda > 1$) → flue gas + heat

25%

energy consumption - pyrolysis:

fuel + heat → gas + char/coke

75%

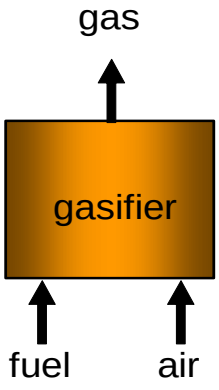
+

gasification:

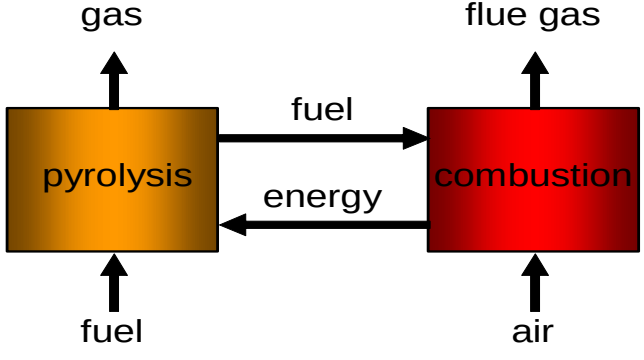
fuel + air (λ~0.3) → gas + char/coke

Direct and Indirect Gasification

- Direct:
  - one vessel
  - all reactions



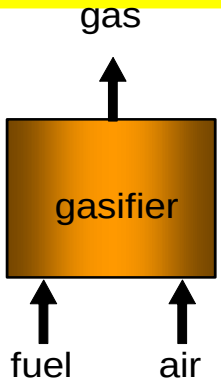
- Allothermal:
  - two coupled reactors
  - combustor supplies heat



Allothermal gasification

Direct gasification

fuel + air (λ~0.3) → gas + char

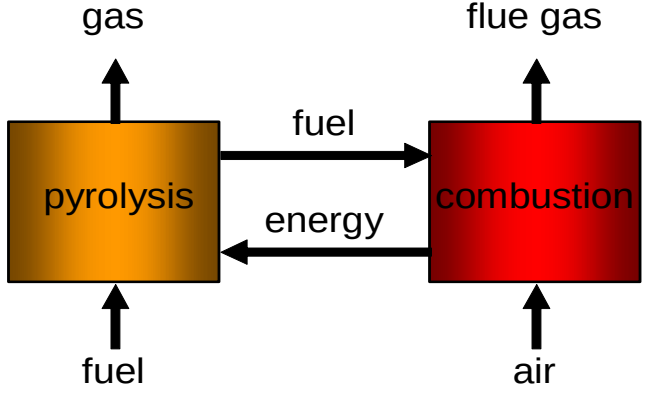


Combustion

fuel + air (λ > 1) → flue gas + heat

Pyrolysis

fuel + heat → gas + char/coke

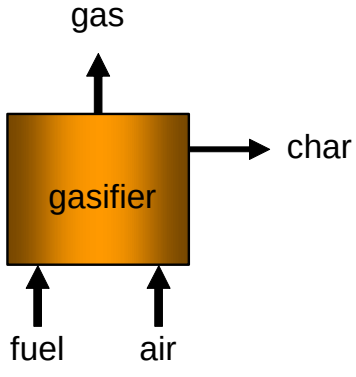


GASIFICATION

1st and 2nd Generation

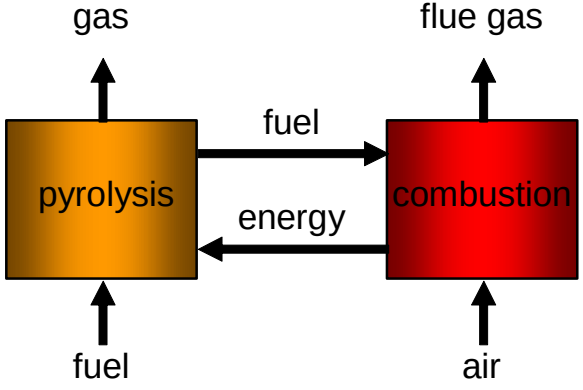
Direct Gasification

- 50% N_2 in gas
- Incomplete carbon conversion
- Acceptable conversion (>90%) requires high temperature, much steam, small fuel size, high residence time



Allothermal / Indirect Gasification

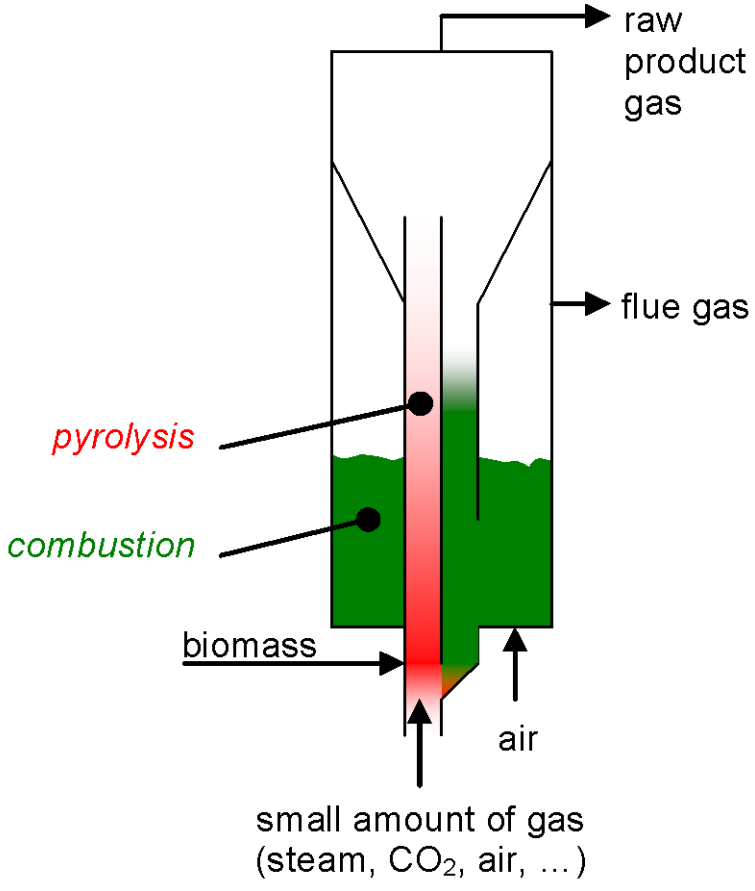
- N_2-free gas without ASU
- Full carbon conversion
- Additional degree of freedom: temperature, steam, fuel size, residence time



Allothermal Gasification
Milena Technology

- Complete conversion
- High efficiency
- Compact design
- 10-15 MJ/Nm^3 producer gas
- Test facilities at ECN
- Tested: wood, demolition wood, grass, lignite, digestion residue, straw, RDF

www.milenatechnology.com



Milena product gas composition

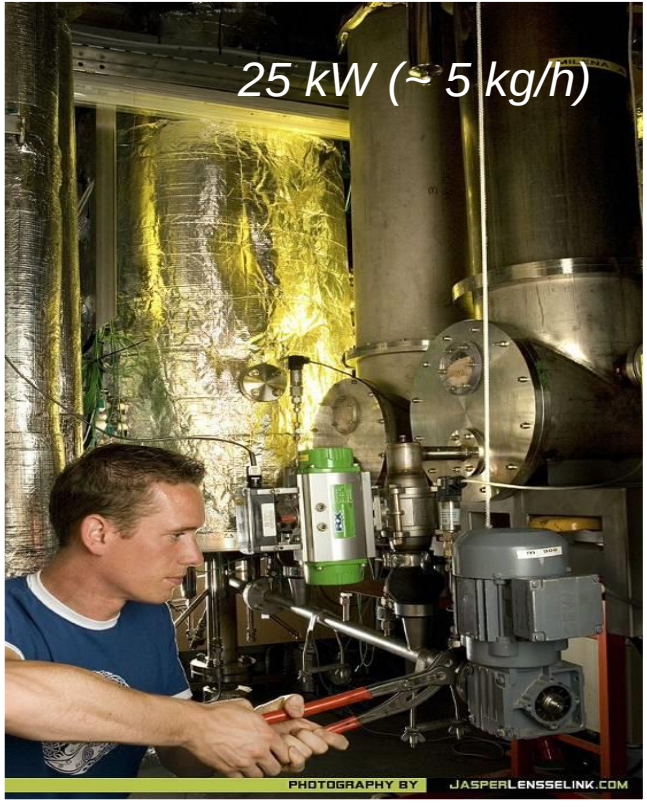
component	concentration	unit
CO	40	vol% dry basis
H_2	24	vol% dry basis
CH_4	15	vol% dry basis
C_2H_x	4	vol% dry basis
C_6H_x	1	vol% dry basis
tar	40	g/Nm^3 dry basis
N_2	4	vol% dry basis
CO_2	11	vol% dry basis
H_2S, COS, NH_3, …	…	

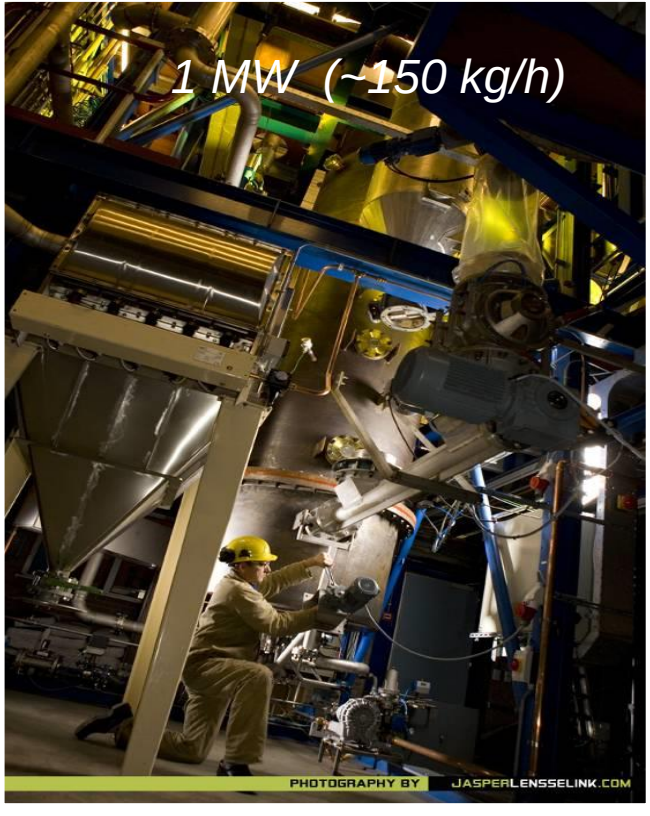
measured in 0.8 MW MILENA pilot plant at ECN: clean wood, olivine bed material, steam to riser, ~850°C

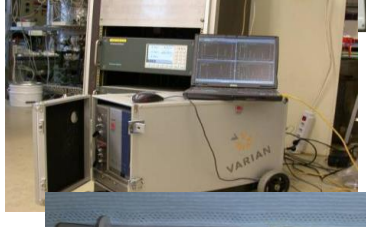
Tested feedstocks

- Clean Wood
- Demolition Wood
- Straw
- Soya stalk
- High-ash coal
- Lignite
- RDF
- Sunflower husks

Milena Technology test facilities at ECN







Project in Development
12 MWth in Alkmaar, The Netherlands

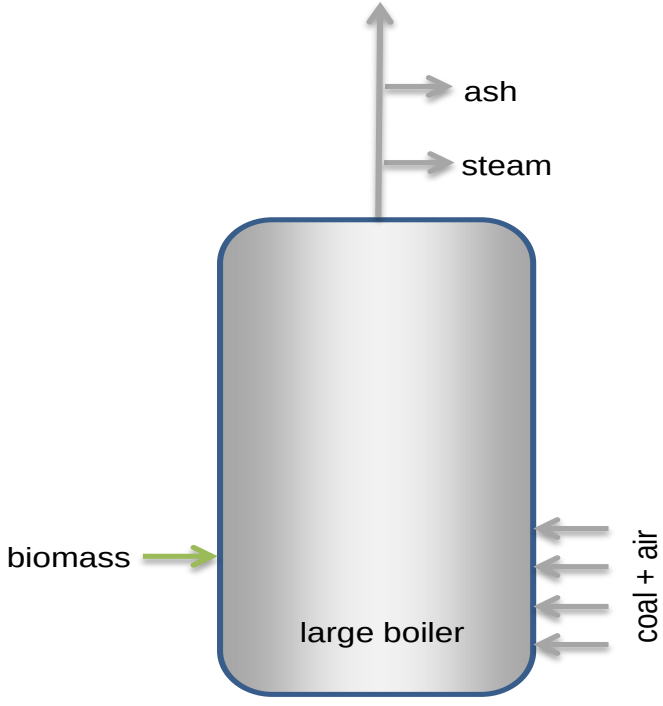
- 12 MW_{th} MILENA and OLGA producing green power
- Currently detailed engineering
- FID in mid 2013
- Construction 2013/2014
- Start-up 2015

HVC
gasunie
gemeente ALKMAAR
Provincie Noord-Holland

Comparing the options

Direct co-firing

- All energy to boiler
- All ash in boiler, so 'limited' to clean biomass
- Biomass needs to be pulverized

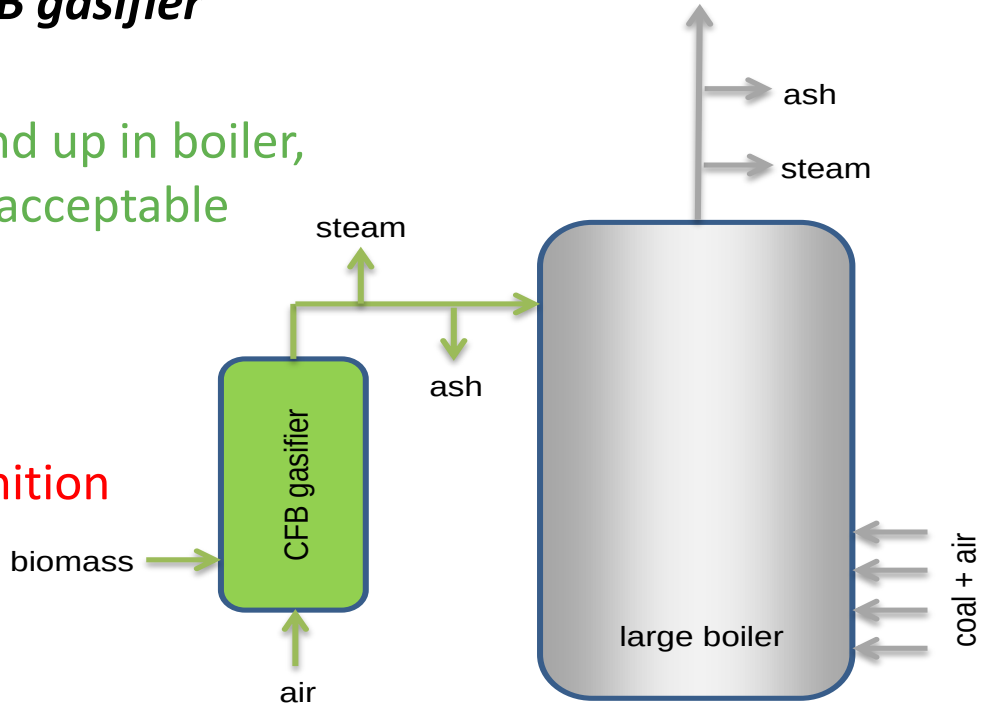


Comparing the options
indirect co-firing through CFB gasifier

Indirect co-firing through CFB gasifier

- Only part of the ash will end up in boiler, so (more) low quality fuel acceptable

- Energy loss by ash/char
- Ash/char deposit problem
- Ash/char danger of self-ignition

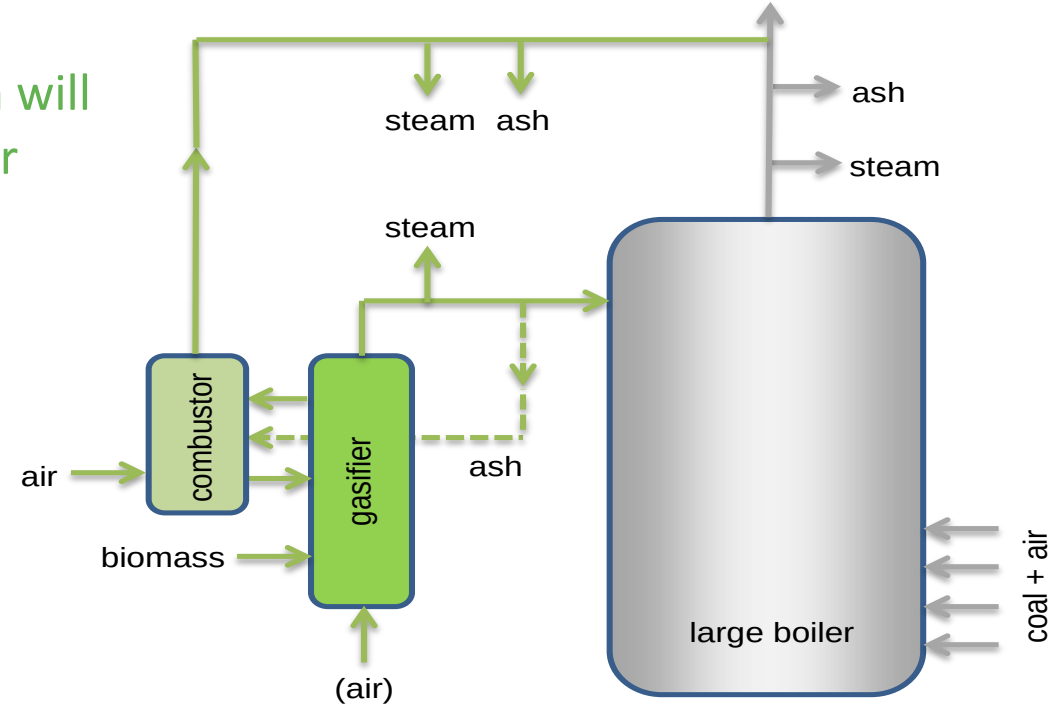


Comparing the options

- ***Indirect co-firing through allothermal gasifier***

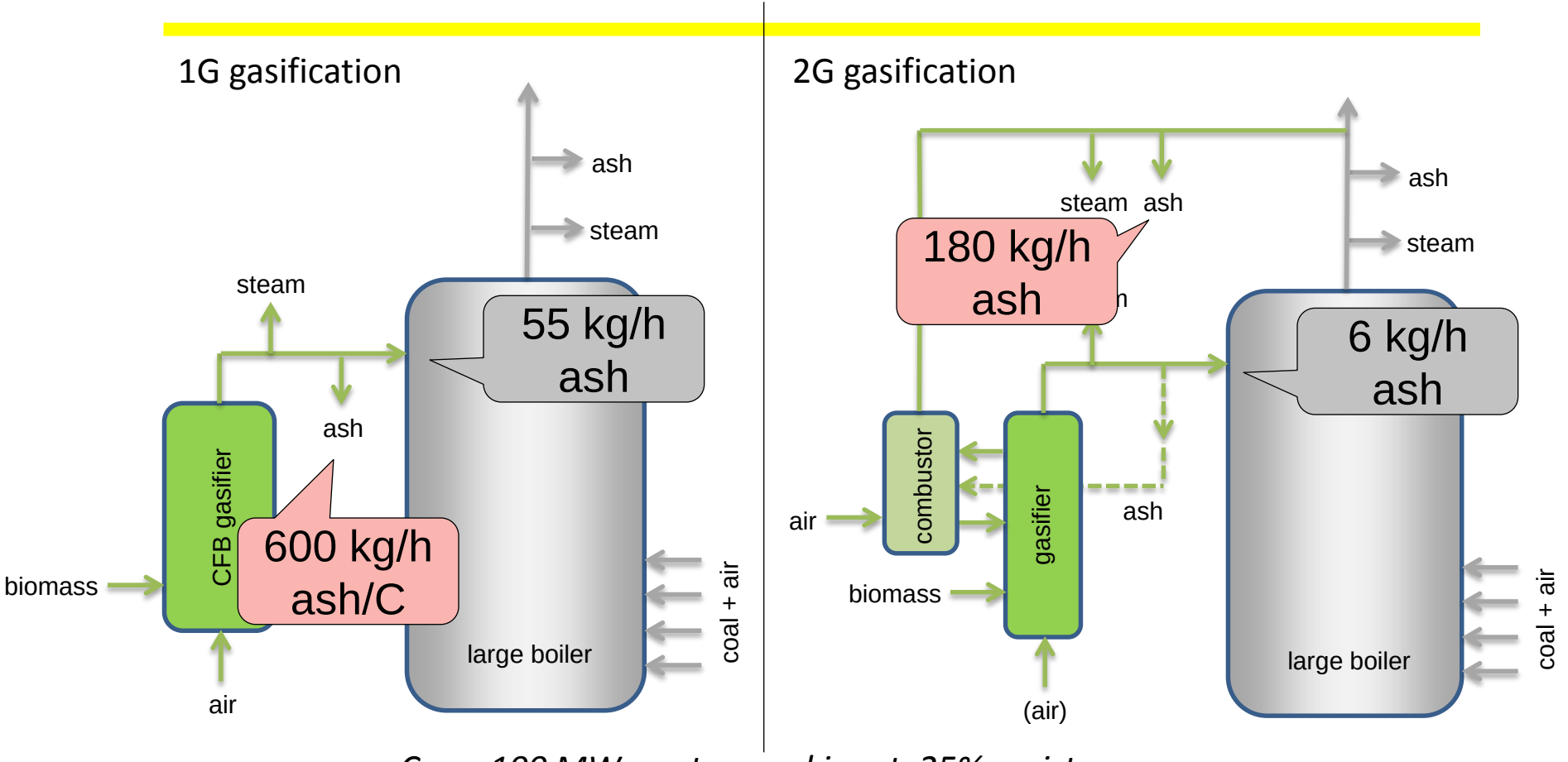
- Only small part of the ash will end up in boiler, so lower quality fuel acceptable
- No combustible waste

- Relatively complex
- New technology



Use of lower quality/cost fuels

Decreased ash load in boiler



Case: 100 MW waste wood input, 25% moisture

Indirect Co-Firing

- Indirect co-firing through gasification enables high share of low-quality, low-cost biomass/waste
  - Because intermediate cleaning (partly) removes ash components, fuel specifications can be relaxed
- Coal power station is asset in transition to renewable energy
- CFB gasifier is *proven* technology
- Allothermal gasifier is *promising* technology…

Allothermal versus CFB gasifier

for indirect co-firing

- No carbon in ash: less waste, no risk of self-ignition)
- Less ash to boiler: less fouling, less corrosion, less coal ash quality issues
- Higher efficiency
- Lower gas volume to boiler: no nitrogen from air
- Freedom to operate at lower temperature (no conversion penalty): higher fuel flexibility, better ash removal, higher efficiency

Thank you for your attention
and
looking forward to cooperate with you
on profitable biomass projects

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