Starfire Energy

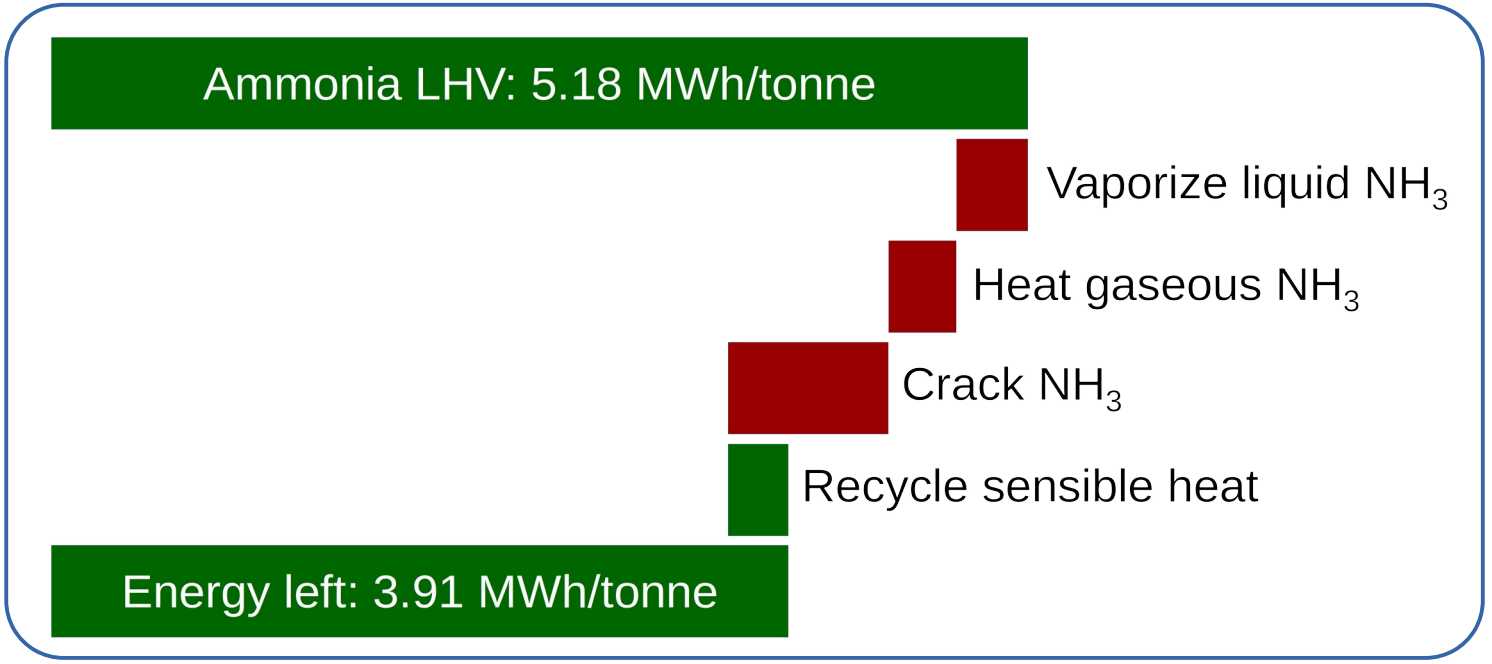
MAKING SUSTAINABLE ENERGY A REALITY

Cracking ammonia for NH_3+H_2 blends or high purity H_2

17 November 2020

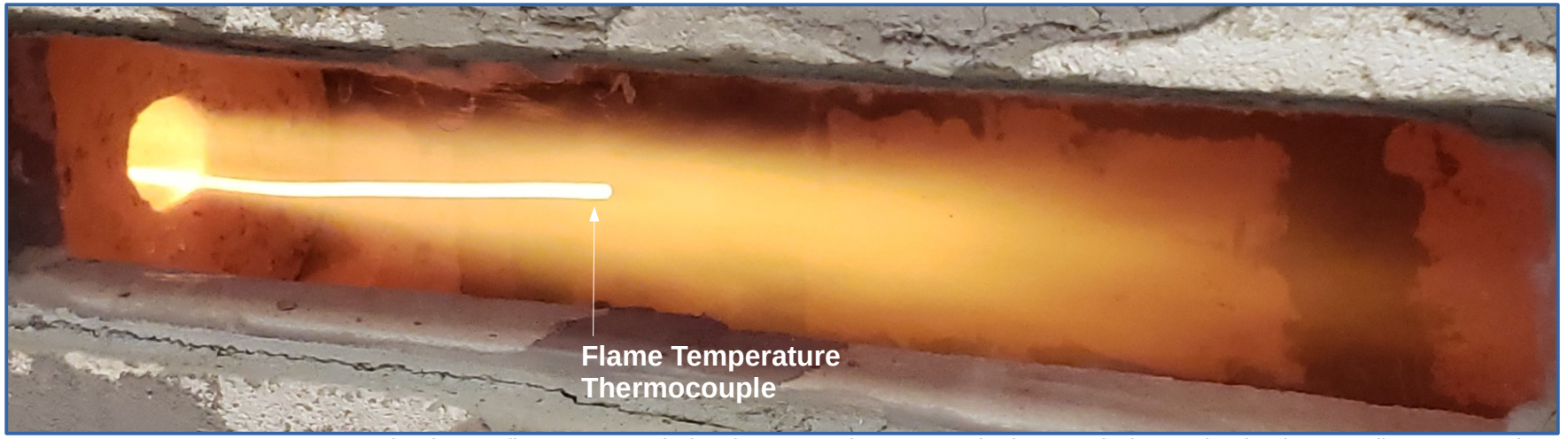
Joe Beach

Use ammonia as a direct fuel when possible



- Cracking consumes ~25% of stored energy *if done perfectly*
- Strong incentive to minimize cracking

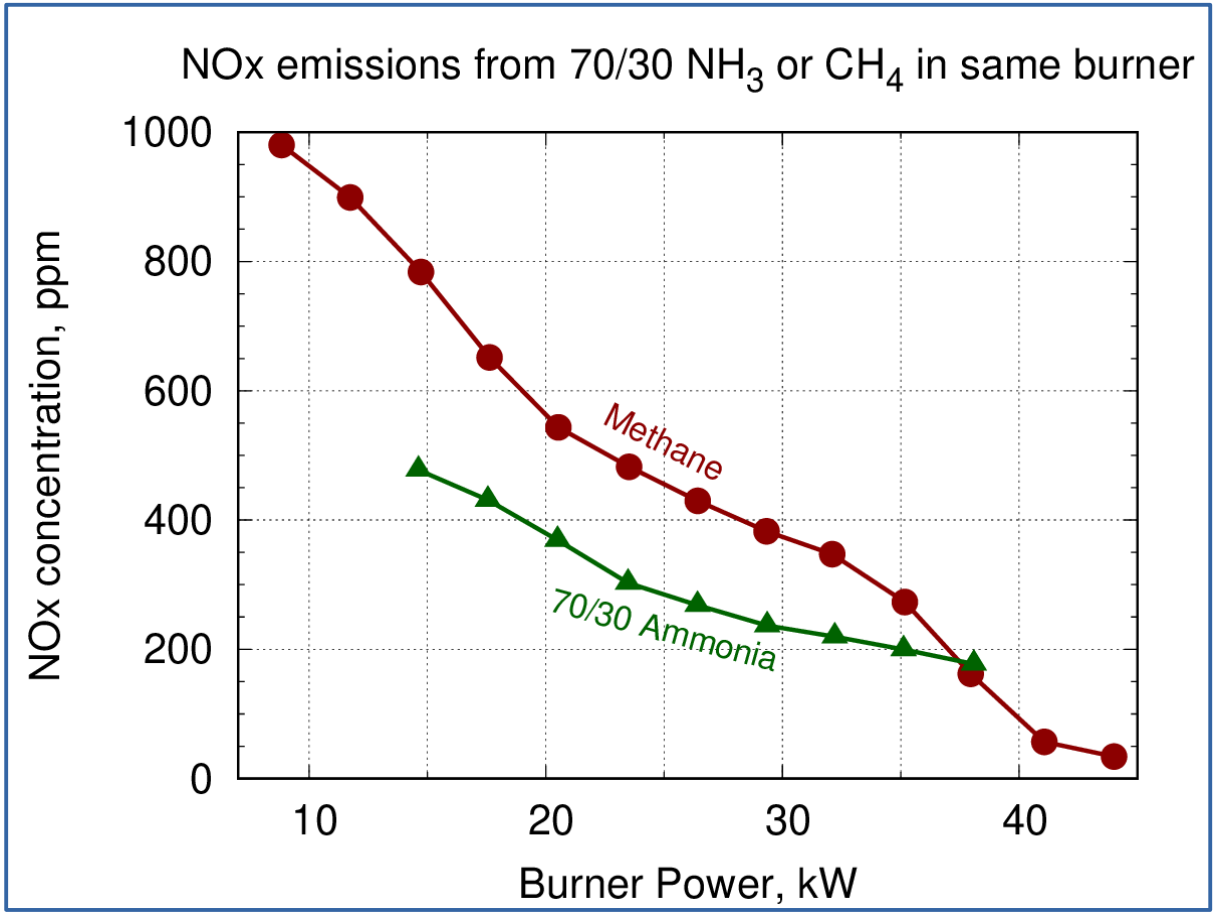
Pure + cracked NH_3 burns like natural gas



38kW burner flame, 70% mole fraction ammonia, 30% cracked ammonia (H2 and N2). Photo credit: Jenn Beach

- Commercial 44 kW / 150,000 BTU/h natural gas burner
- 70% NH_3 + 30% simulated cracked NH_3
- Stoichiometric fuel:air ratio

70+30 blend has reasonable NOx emissions



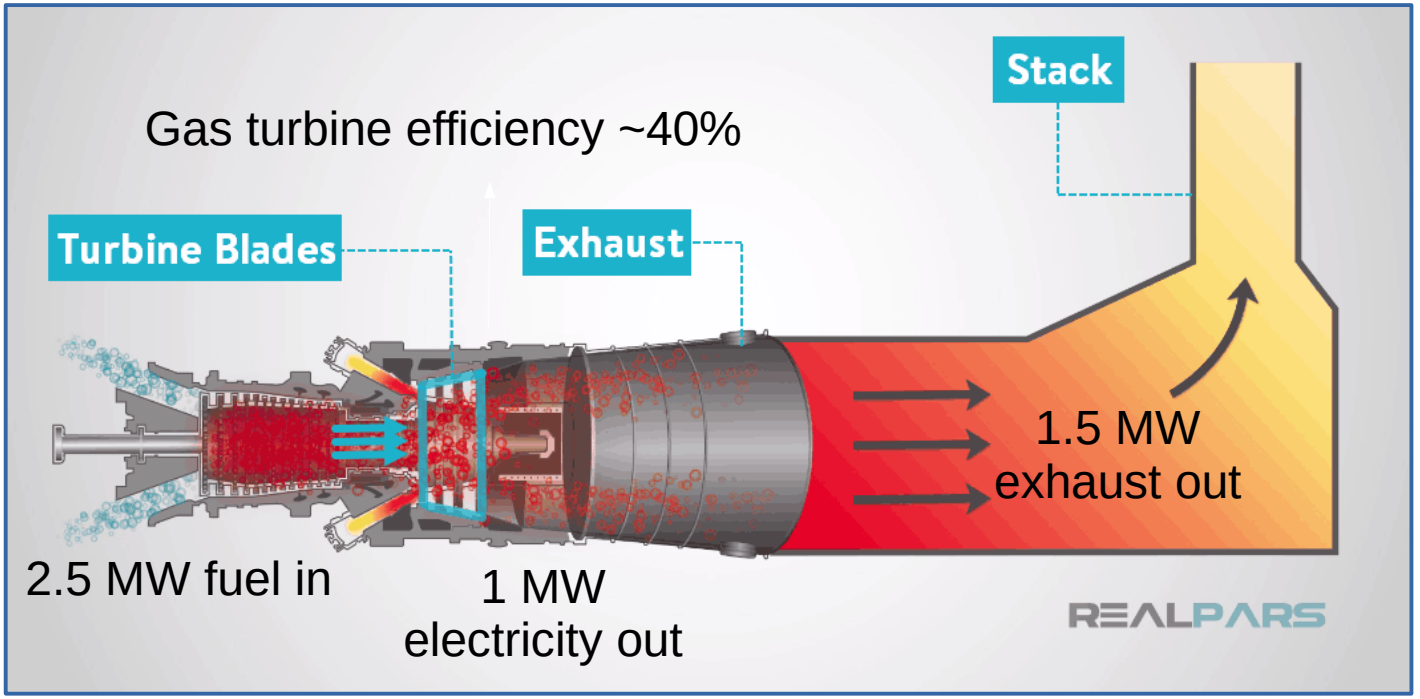
Methane fuel emissions

- NOx drops with burner power
- Sharp drop at 36-38 kW
- 50 ppm NOx at high power

Ammonia fuel emissions

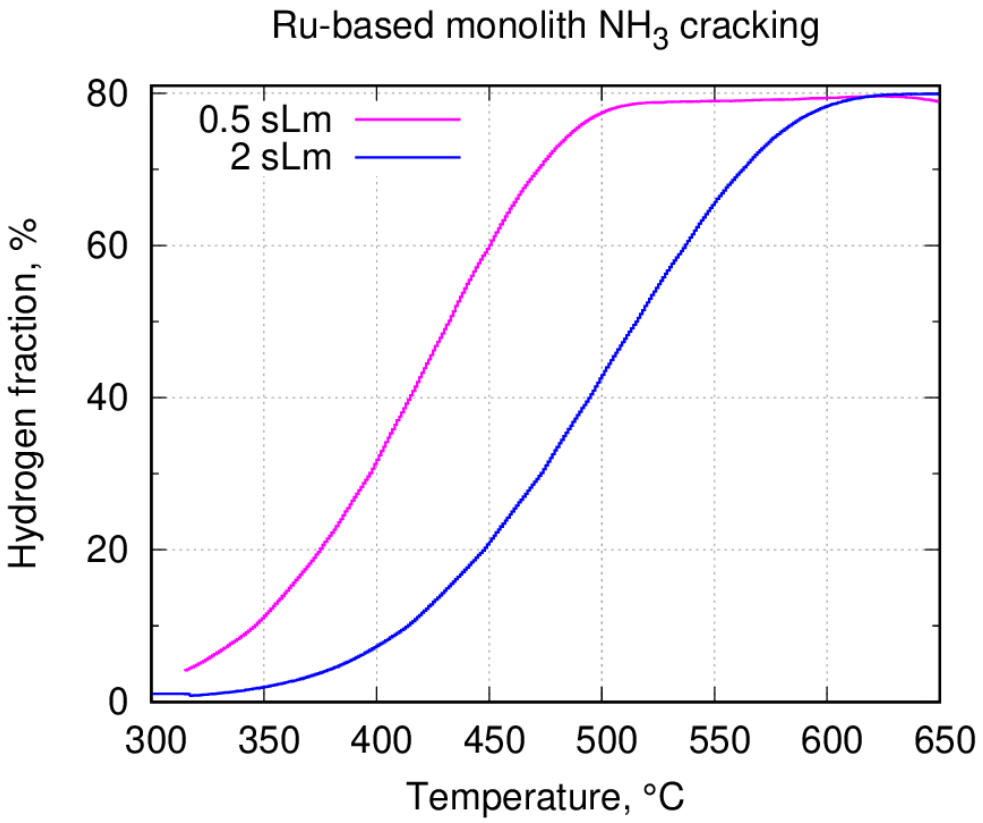
- NOx drops with burner power
- NOx < 200 ppm at 38 kW
- Max power limited by air blower

Gas turbines have waste heat opportunity



- 70/30 blend: 0.183 MW heat input for cracking
- Hot exhaust becomes useful heat for cracking

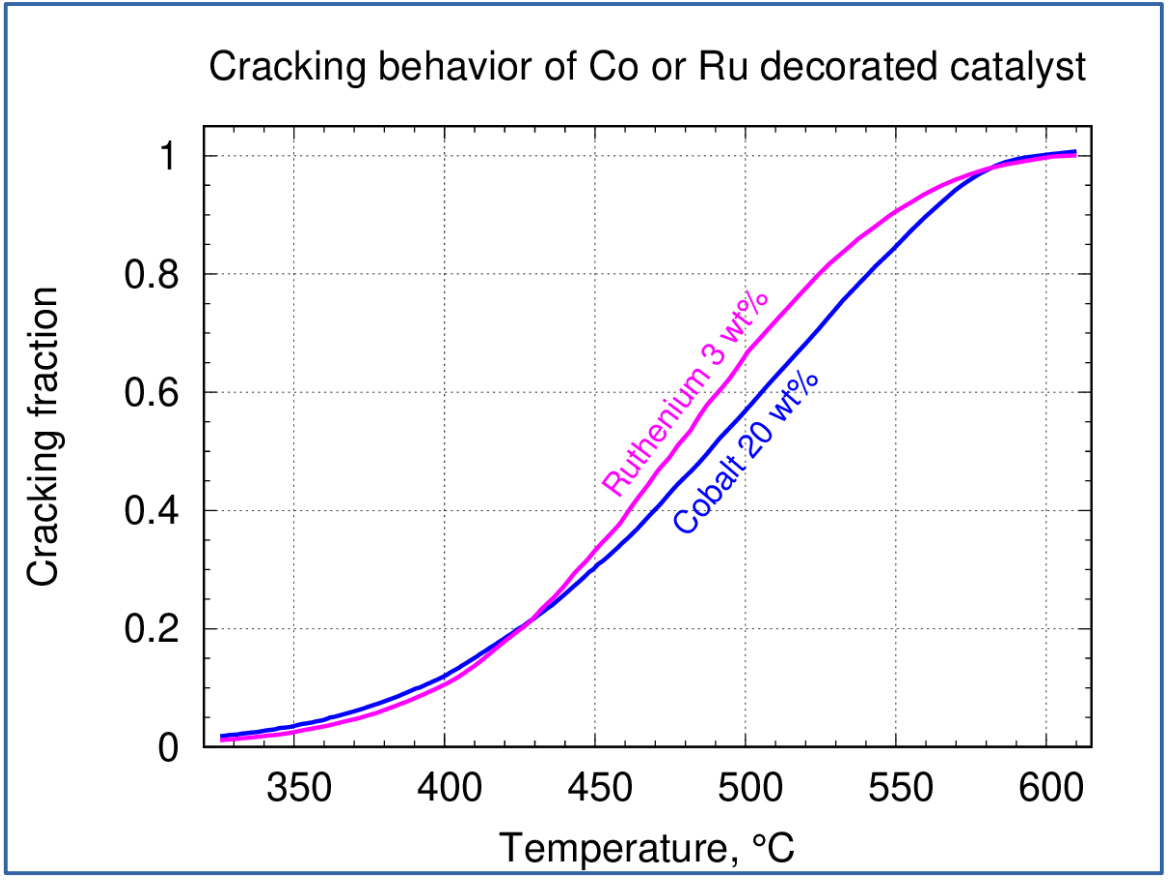
Cracking is compatible with exhaust heat



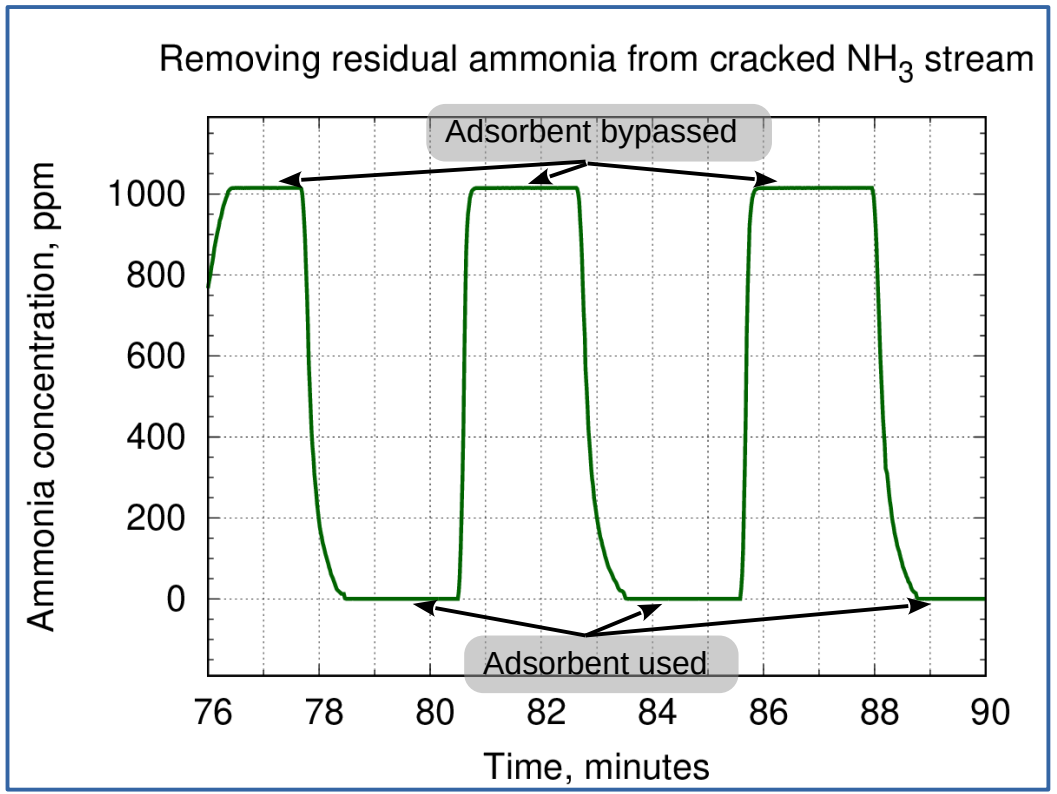
- Starfire Energy catalyst
- Bonded to metal monolith
- High catalyst utilization
- Scaling up process

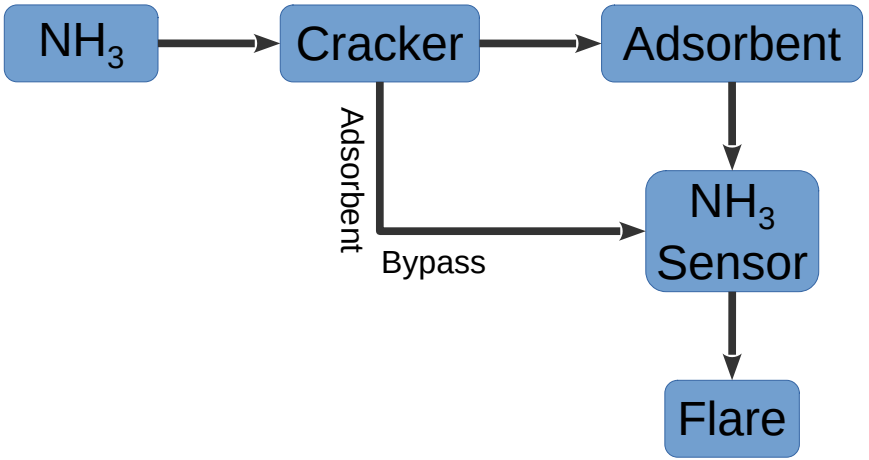
Cobalt catalyst works also

- Both on B2CA support
- Both on metal monolith
- Both 1 sLm NH_3 flow
- Cobalt stable during 90 h continuous test



Residual NH_3 removal demonstrated





- 0-1000 ppm NH_3 detector
- "Full cracking" NH_3 > 1000 ppm
- Nominally 0 ppm residual NH_3
- Path to 99.999%, >700 bar H_2

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Thank you.

I’m happy to answer questions during the panel discussion

Joe.Beach@StarfireEnergy.com