catalysis institute

GreenQUEST
Innovation for clean household fuel

Accelerating energy access through clean cooking – GreenQUEST Project

N Fischer

The 8th RD20 Conference

Accelerating Clean Energy Innovation: Fram Africa to the World

October 2026

Federal Ministry
of Research, Technology
and Space

UNIVERSITY OF CAPE TOWN
IYUNIVESITHI YASEKAPA • UNIVERSITEIT VAN KAAPSTAD

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HYENA HYDROGEN ENERGY APPLICATIONS

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Tasneem Isaacs
JV Fletcher

CSIR

Ashton Swartbooi

GreenQUEST
Fuel for Life

Clean Cooking in Africa

2 BILLION PEOPLE Lack access to modern & clean household fuels

Liquefied Petroleum Gas

- ✓ Easily stored & highly portable
- ✓ Efficient & clean burning

Replace traditional household fuels [2]

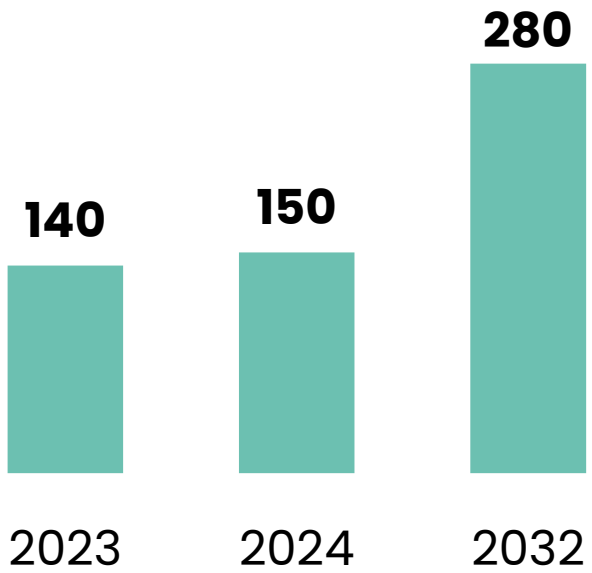
Household cooking & heating [1,2]

Industrial heating & refrigeration [1]

Autogas

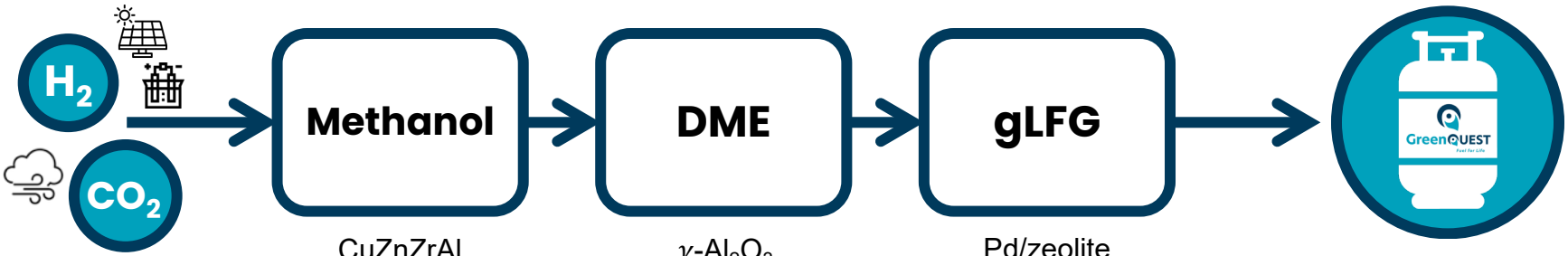
LPG Market Projections

$ billion [1]



[1] Fortune Business Insights. 2023. *LPG Market and Forecast, 2024-2032*. https://www.fortunebusinessinsights.com
[2] LPG SA. 2020. *South African LPG*. https://www.lpgas.co.za/new-era/

Liquefied Fuel Gas

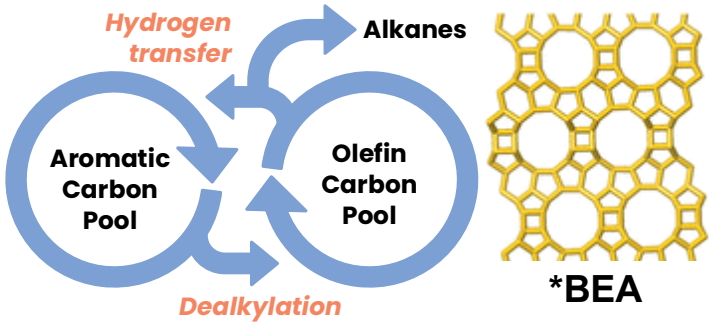


Typical one-pot synthesis over hybrid catalysts [1,2]

- Complex product stream & high P_{H_2O}
- High ΔH_{rxn} starting from methanol

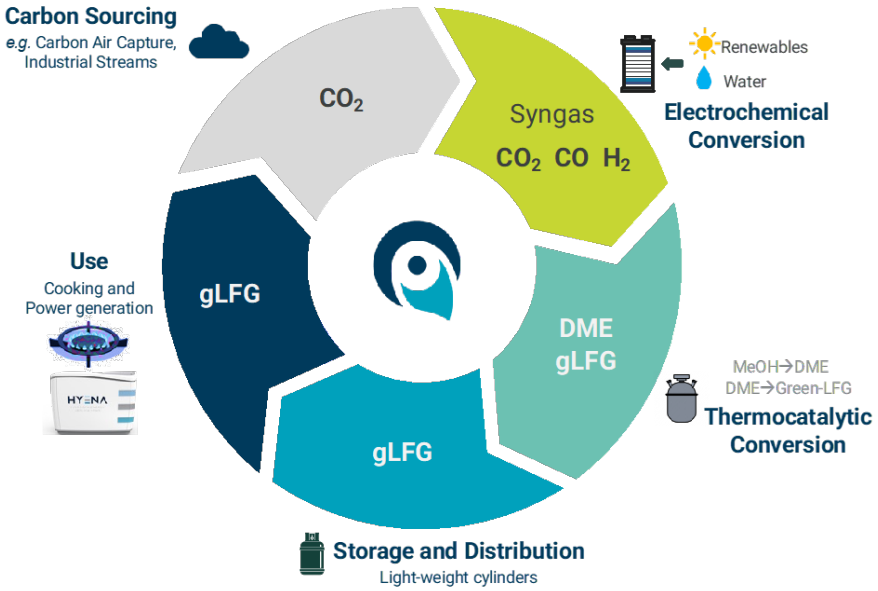
Leads to reaction segregation with inter-stage H_2O removal.
Allows for individual stage optimization: ✓ Methanol ✓ DME

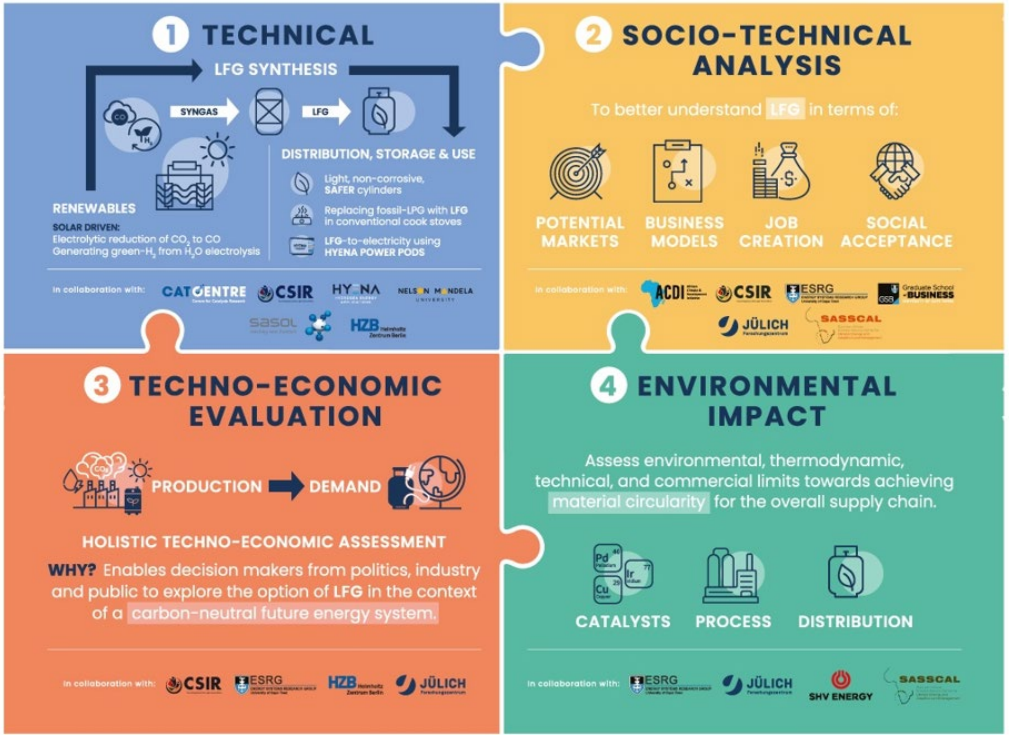
💡 **DME → LFG not yet commercially demonstrated**



Hydrocarbon pool mechanism [3,4]

[1] Olsbye, et al., (2012) [2] Li C, Fujimoto K. (2015) [3] Svelle, et al., (2007) [4] Ilias, S. Bhan, A. (2013)


Carbon Sourcing
e.g. Carbon Air Capture, Industrial Streams
CO_2
Syngas
CO_2 CO H_2
Renewables
Water
Electrochemical Conversion
Use
Cooking and Power generation
HYENA
gLFG
DME
gLFG
gLFG
MeOH→DME
DME→Green-LFG
Thermocatalytic Conversion
Storage and Distribution
Light-weight cylinders


1 TECHNICAL
LFG SYNTHESIS
SYNGAS
LFG
RENEWABLES
SOLAR DRIVEN:
Electrolytic reduction of CO_2 to CO
Generating green-H_2 from H_2O electrolysis
DISTRIBUTION, STORAGE & USE
Light, non-corrosive, SAFER cylinders
Replacing fossil-LPG with LFG in conventional cook stoves
LFG-to-electricity using HYENA POWER PODS
in collaboration with:
CATCENTRE
CSIR
HYENA
NELSON MANDELA UNIVERSITY
SASOL
HZB
2 SOCIO-TECHNICAL ANALYSIS
To better understand LFG in terms of:
POTENTIAL MARKETS
BUSINESS MODELS
JOB CREATION
SOCIAL ACCEPTANCE
in collaboration with:
ACDI
CSIR
ESRG
Graduate School of BUSINESS
JÜLICH
SASSCAL
3 TECHNO-ECONOMIC EVALUATION
PRODUCTION
DEMAND
HOLISTIC TECHNO-ECONOMIC ASSESSMENT
WHY? Enables decision makers from politics, industry and public to explore the option of LFG in the context of a carbon-neutral future energy system.
in collaboration with:
CSIR
ESRG
HZB
JÜLICH
4 ENVIRONMENTAL IMPACT
Assess environmental, thermodynamic, technical, and commercial limits towards achieving material circularity for the overall supply chain.
CATALYSTS
PROCESS
DISTRIBUTION
in collaboration with:
ESRG
JÜLICH
SHV ENERGY
SASSCAL

DME to gLFG

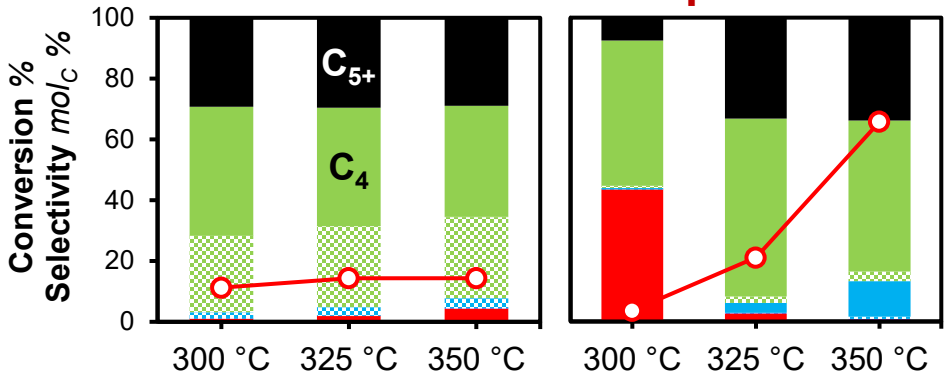
DME conversion
0.1 wt % Pd/Beta-150

C_1 C_2 C_3 C_4
C_{5+} $C_{2=}$ $C_{3=}$ $C_{4=}$

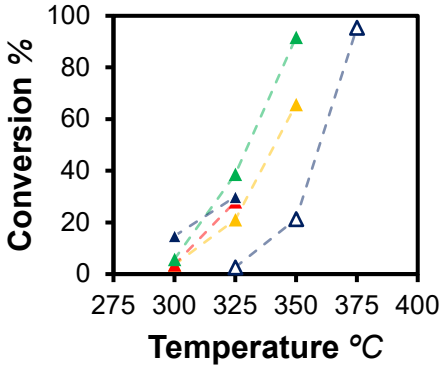
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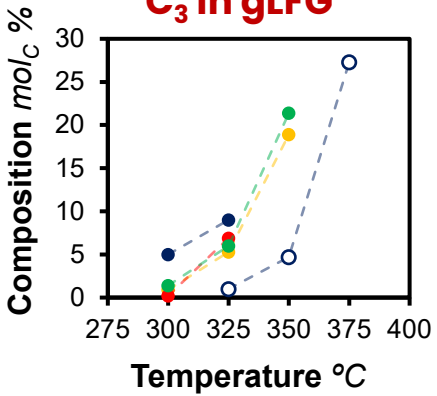
Impact of Pd



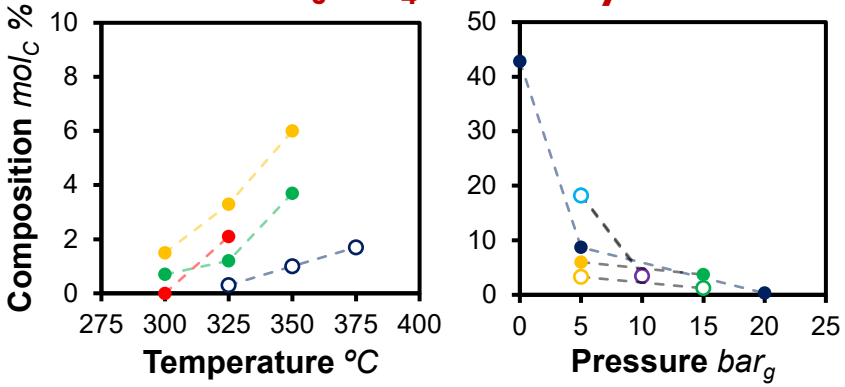
DME Conversion



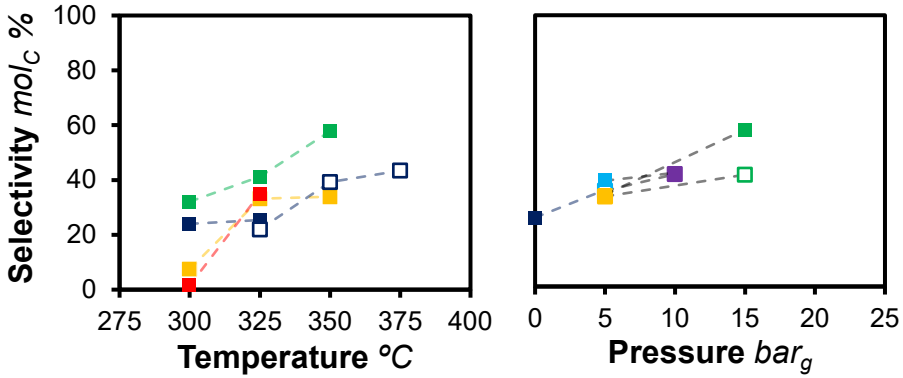
C_3 in gLFG



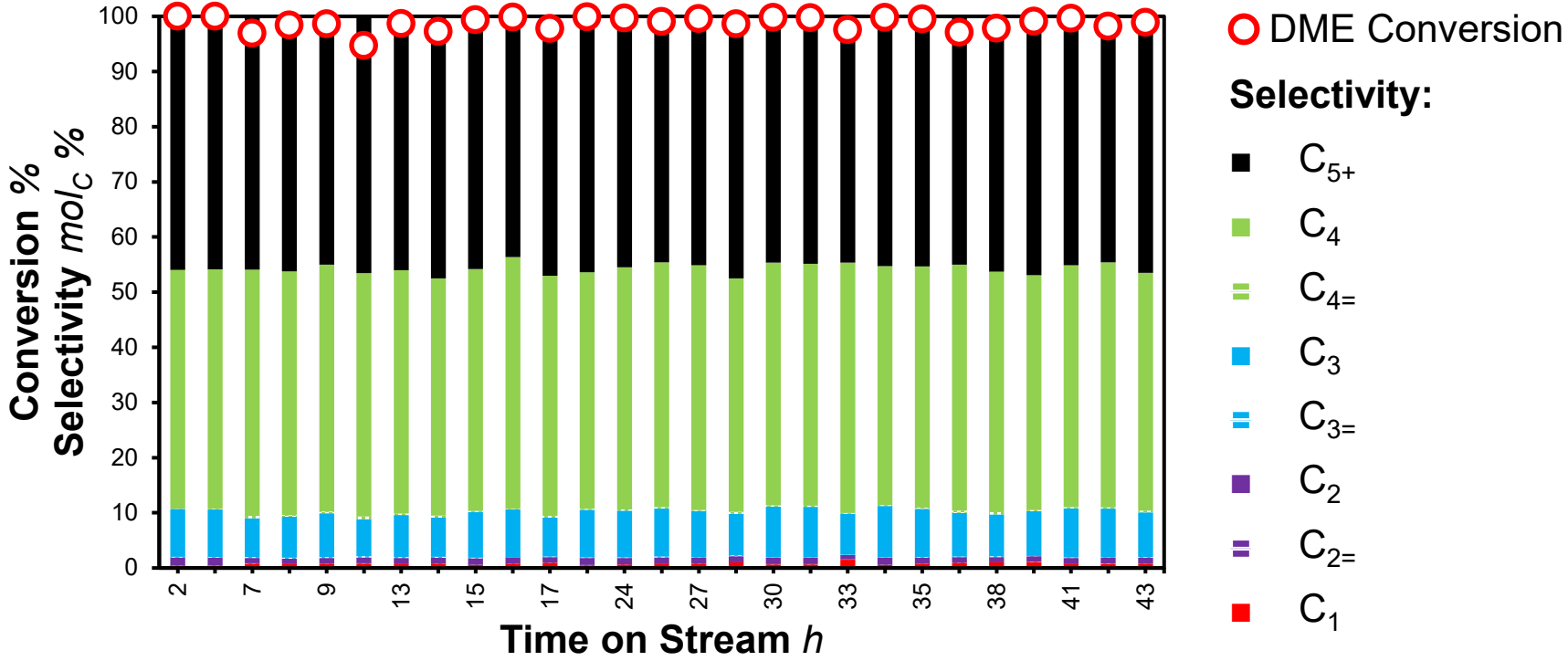
C_3 & C_4 Olefinicity



C_{5+} Selectivity



DME to gLFG (total conversion)

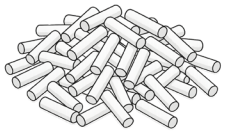


Catalyst & Process Upscale

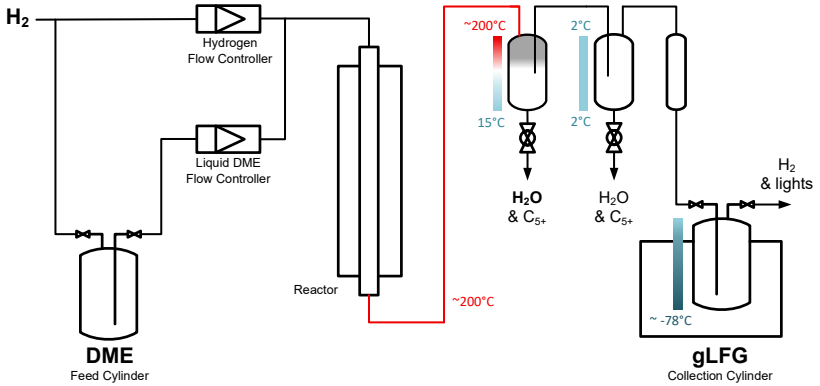


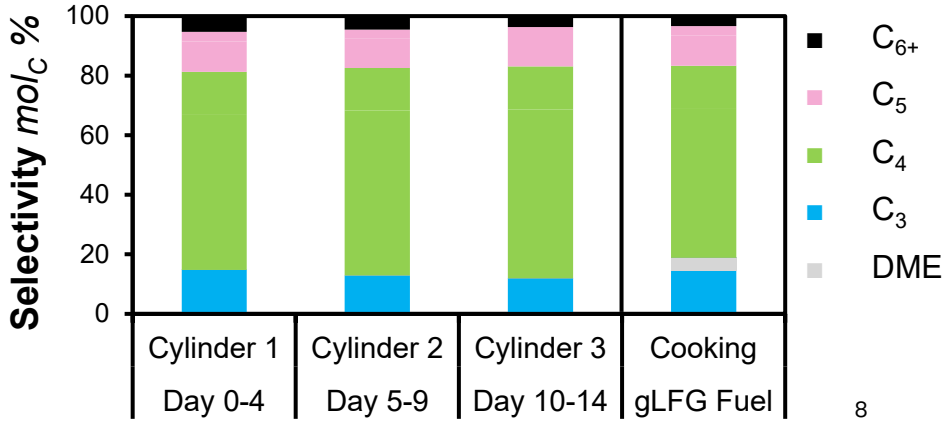
0.1 wt % Pd/H-Beta-150
Powder
$Pd(NO_3)_2.H_2O$

Catalyst scale-up for bulk gLFG synthesis [6]



0.2 wt % Pd/H-Beta-150
Extrudate 1/16“
$Pd(NH_3)_4(NO_3)_2$ [5]





[5] de Graaf, J. et al., (2001) [6] Roberts et al., (2026) *in press*

Platinum Group Metals (PGMs)



PGMs

✓ Mined in SA

✓ Highly catalytically active

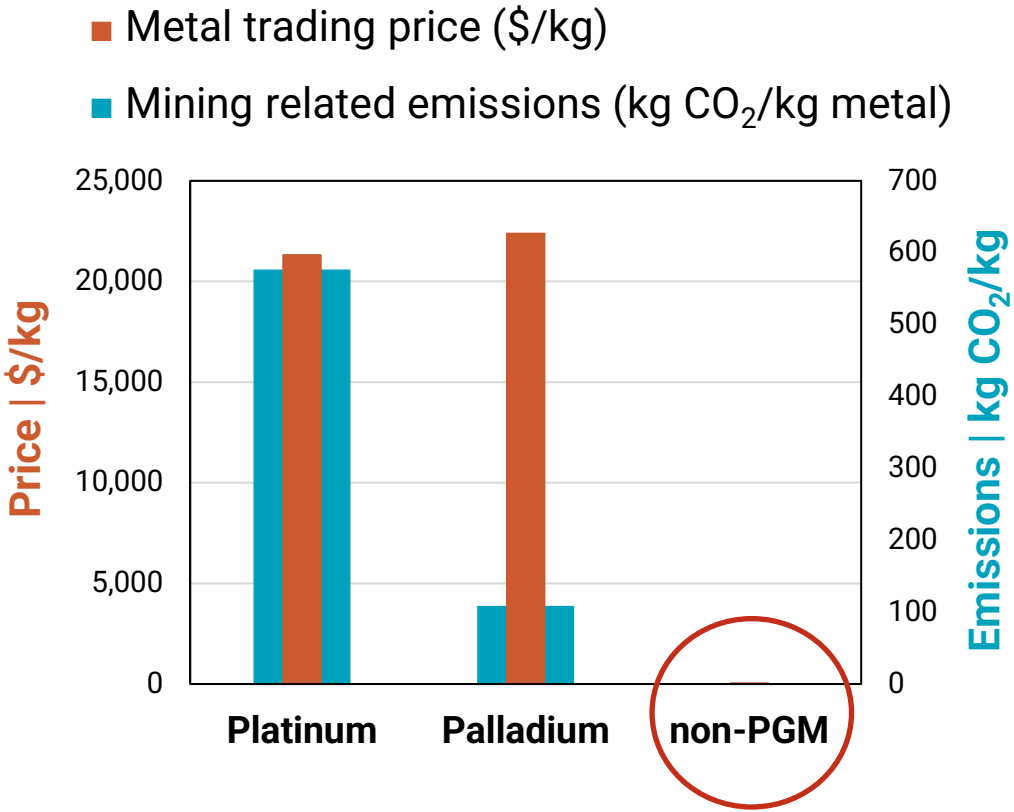
✗ …but expensive & rare

∴ Alternative metals necessary

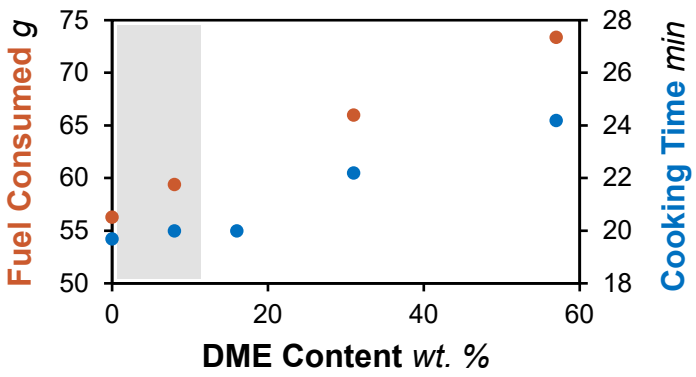
Non-PGMs

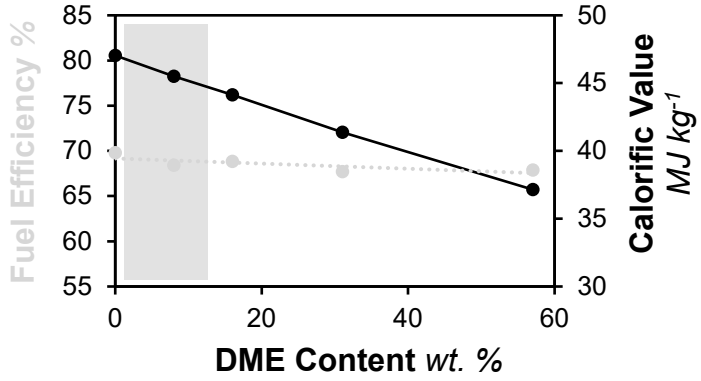
✓ Affordable & abundant

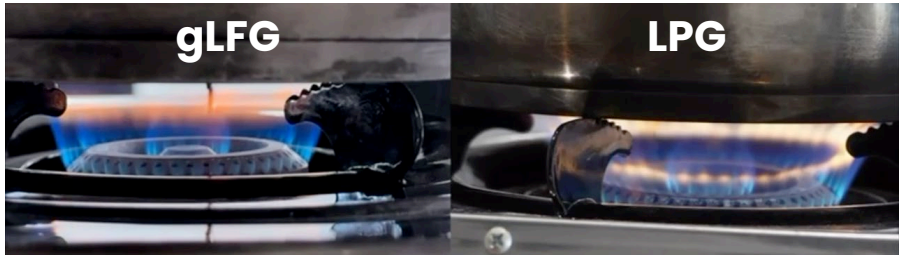
✓ Catalytically active



gLFG Demonstration – Cooking

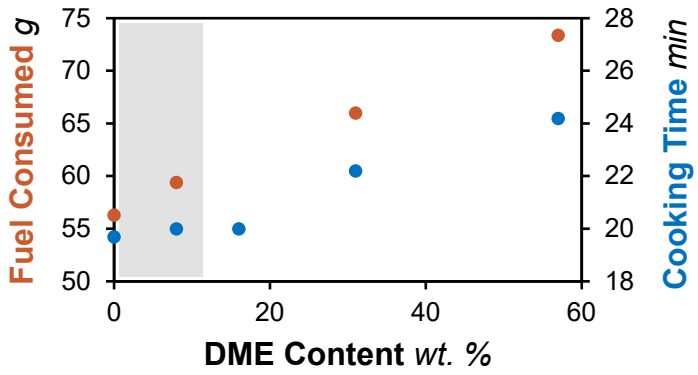


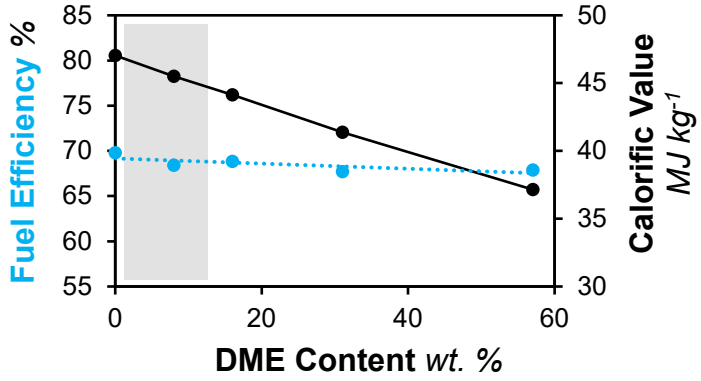


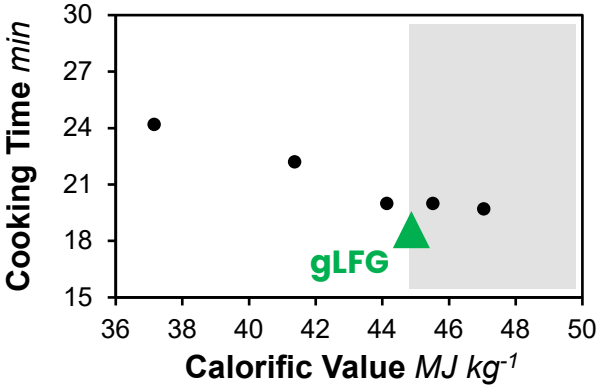


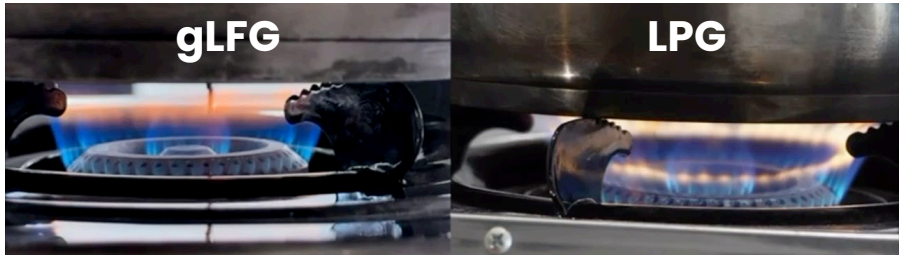
[6] Roberts et al., (2026) *in press*

gLFG Demonstration – Cooking



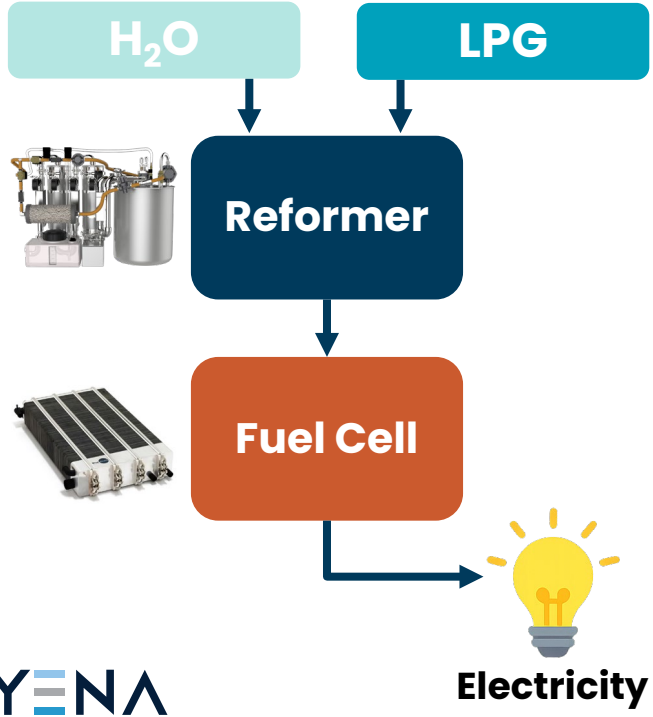


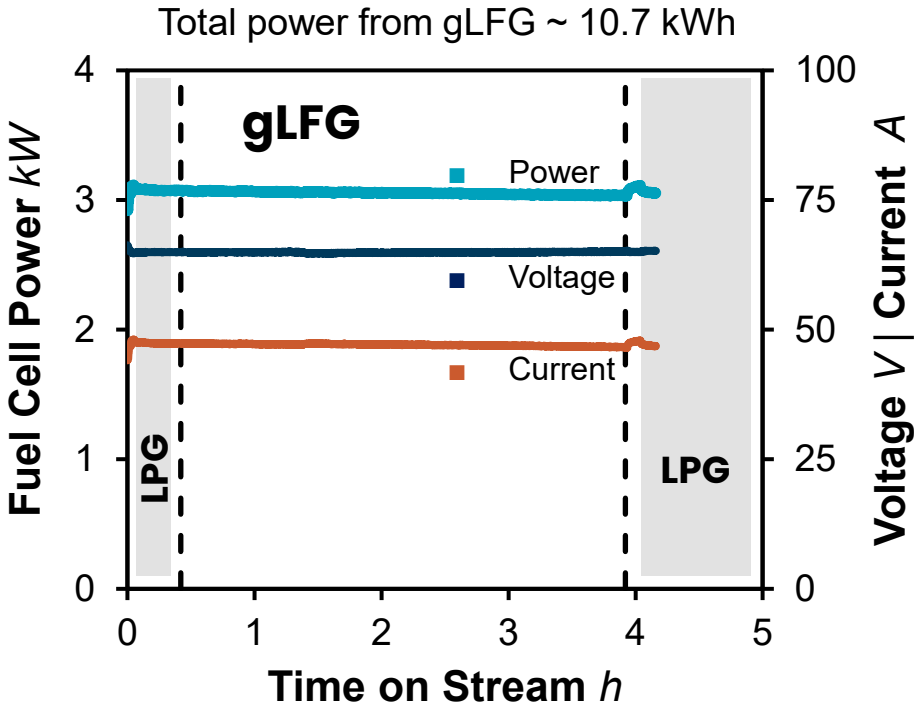




[6] Roberts et al., (2026) *in press*

gLFG Demonstration – Electricity





Process Economics

Fossil-LPG **retail** prices (R/kg)

- South Africa 36
- Germany 42
- USA 19

CO_2
$80/ton

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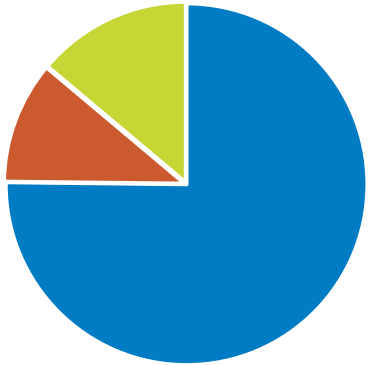
CO_2

green-H_2

2030

83 R/kg gLFG

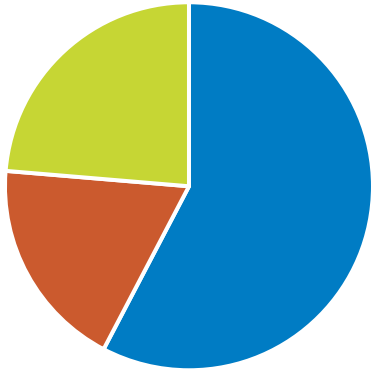
4 $/kg H_2



2050

56 R/kg gLFG

1.8 $/kg H_2

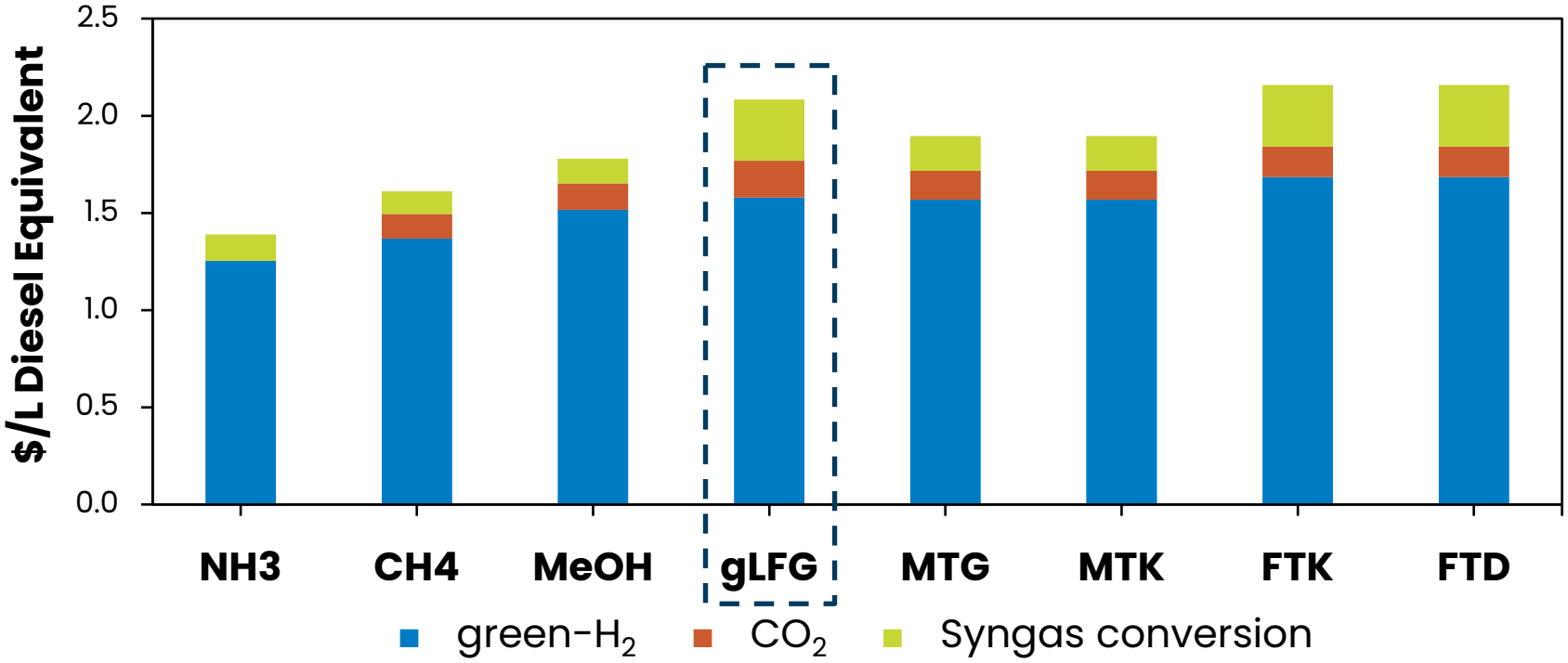


gLFG = 2.3 – 1.6 x fossil LPG

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Federal Ministry of Research, Technology and Space

gLFG vs Other e-Fuels



Cost of e-fuels to gate

[7] Soler, A., Dekeyser, J., Ramasary, A., Gordillo, V., Lilley, W., Schmidt, P., Weindorf, W., Raksha, T., et al. (in press). E-Fuels: A techno-economic assessment of European domestic production and imports towards 2050 - Update. *CONCAWE Aramco.* 24(4):XIV–399.

Conclusions

- **Stable DME → gLFG conversion**
  - Pd/Beta catalyst validated
  - excessive C_{5+} yield
  - low gLFG C_3 content
  - non-PGM catalyst developed
- **Drop-in LPG replacement**
  - cooking application
  - fuel cell power generation
- **gLFG price strongly related to H_2 source**



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Fuel for Life

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CSIR

HYENA HYDROGEN ENERGY APPLICATIONS

SASSCAL Southern African Science Service Centre for Climate Change and Adaptive Land Management

Federal Ministry of Research, Technology and Space