COOL LPG: AN INNOVATIVE PATHWAY TO RENEWABLE LPG

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The Rising Need for Renewable LPG in the Global North

- LPG is an economically efficient, liquid-fuel, energy solution already used by over 2.5 billion people worldwide
  - Global LPG production was about 330 million tonnes in 2022
  - European LPG market: 42 million tonnes in 2021, est. 59 million tonnes in 2027
  - US LPG Market: second largest worldwide, with roughly 5% of US homes being heated with LPG
- rLPG is a drop-in replacement for current applications which cannot be electrified, utilizing existing supply chains as-is

Domestic production of rLPG will play a key role in the transition to a low-cost, low-carbon energy future

1) *GLPGP. Assessing Potential for BioLPG Production and Use within the Cooking Energy Sector in Africa. Available online: glpgp.org/resources.*
2) *WLPGA 2022 Annual Report (available online)*

The Rising Need for Renewable LPG in the Global South

- Globally, 2.3 billion people lack access to clean cooking, leading to an estimated 3.7 million premature deaths a year.
- IEA recognizes LPG is a critical solution for a large part of incremental clean cooking means needed by 2050.
- The WHO considers LPG as a clean alternative that could particularly help growing populations in rural areas of SSA that lack access to clean cooking.
- Cool LPG allows renewable LPG to be produced and distributed in-country.

rLPG can sustainably provide critical energy solutions while meeting international climate targets

1) *IEA Report, "A Vision for Clean Cooking Access for All" (2023). Available online: www.iea.org/reports/a-vision-for-clean-cooking-access-for-all*
2) *WHO Fact sheet, "Household air pollution" (2022). Available online: www.who.int/news-room/fact-sheets/detail/household-air-pollution-and-health*
3) *Chen, K.C. et al., Energies 2021, 14, 3916.*

GTI ENERGY r-LG / r-LPG / r-PROPANE

80-year History of Turning Raw Technology into Practical Energy Solutions

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FOR A BETTER ECONOMY AND A BETTER ENVIRONMENT

SUPPLY ▶ CONVERSION ▶ DELIVERY ▶ UTILIZATION

RESEARCH & DEVELOPMENT

PROGRAM MANAGEMENT

TECHNICAL/ ANALYTICAL

CONSULTING

TRAINING

COMMERCIALIZATION

400+ EMPLOYEES

World-class piloting facilities headquartered in Chicago area

Examples of Commercialized GTI Energy Biomass Conversion Technologies

- Invented IH^2® technology to convert biomass into transportation fuels – **licensed** to CRI Catalyst Company (division of Shell)

- Spun out SunGas Renewables, dedicated to commercial supply of GTI Energy's large-scale biomass gasification technology – **Founded 2019**

GTI Energy's Cool Suite for Biomass Conversion

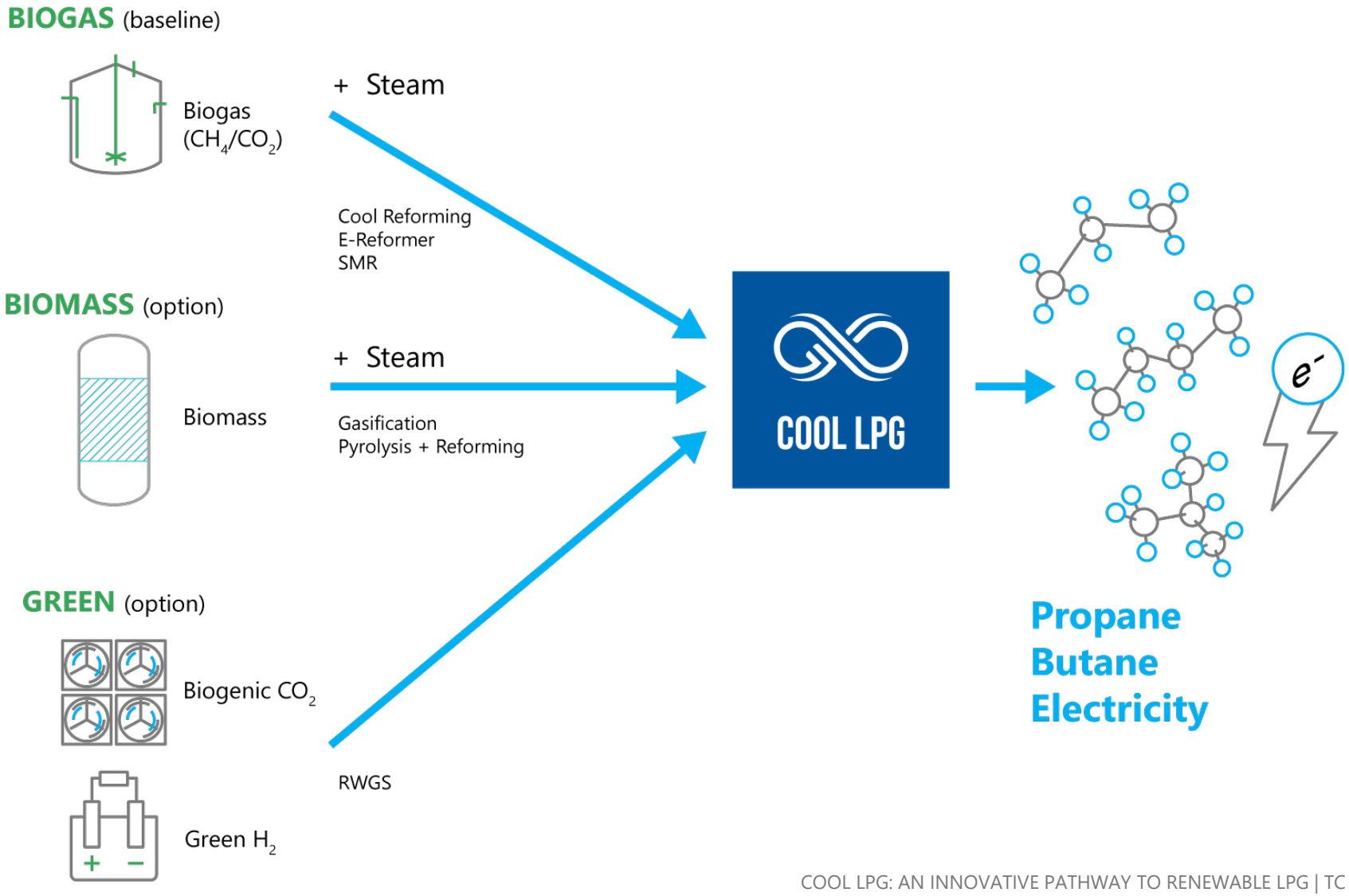
Cool Reforming

Cool GTL

Cool LPG

Leveraging GTI Energy's liquid fuels production platform

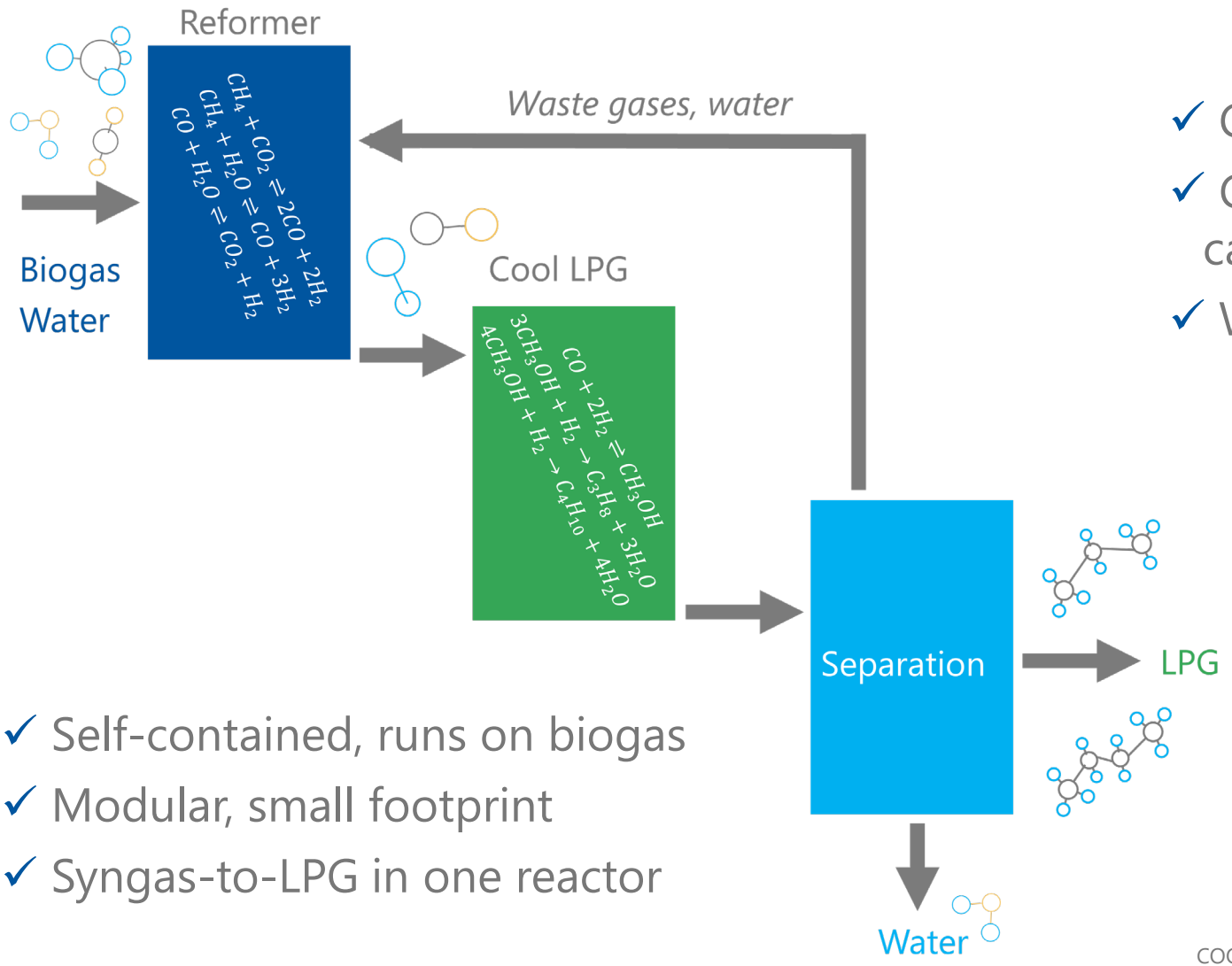
The Cool LPG Process



COOL LPG DEVELOPMENT

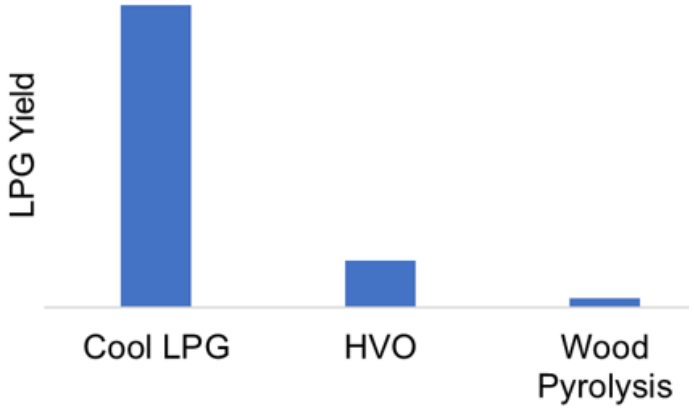
GTI ENERGY TECHNOLOGY

The Cool LPG Process

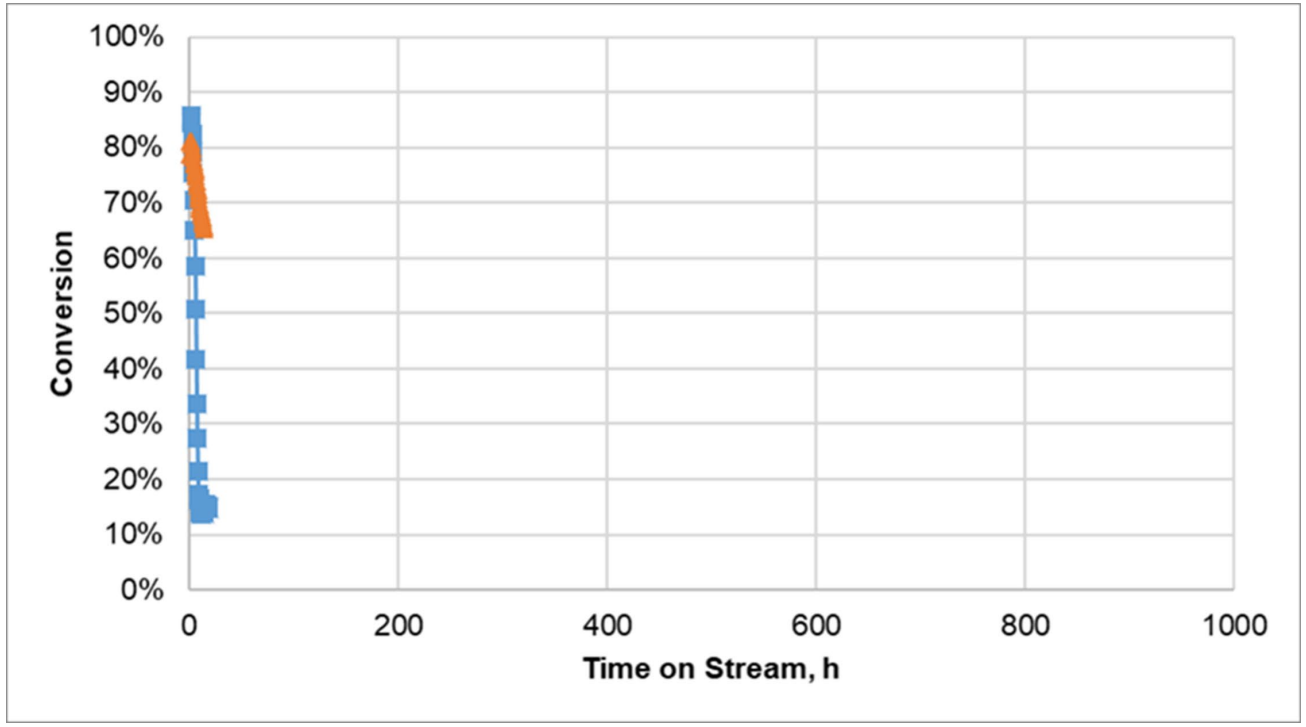


- ✓ Can convert CO_2 to LPG
- ✓ Can reform biogas in the first stage – but can also run on alternative syngas feeds
- ✓ Waste gas can be recycled or used as fuel

- ✓ Self-contained, runs on biogas
- ✓ Modular, small footprint
- ✓ Syngas-to-LPG in one reactor



Process and Catalyst Development at GTI Energy



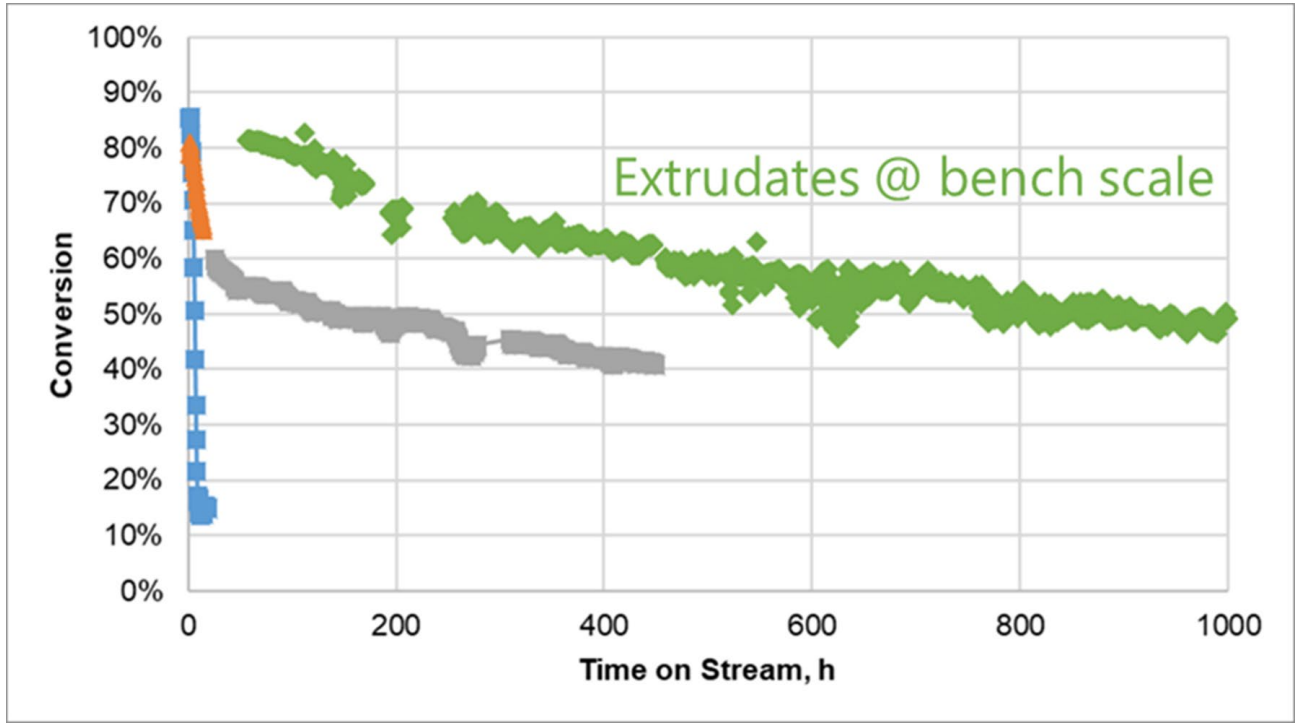
Preliminary catalyst screening tests performed of 10s of hours

-> “B is better than A”

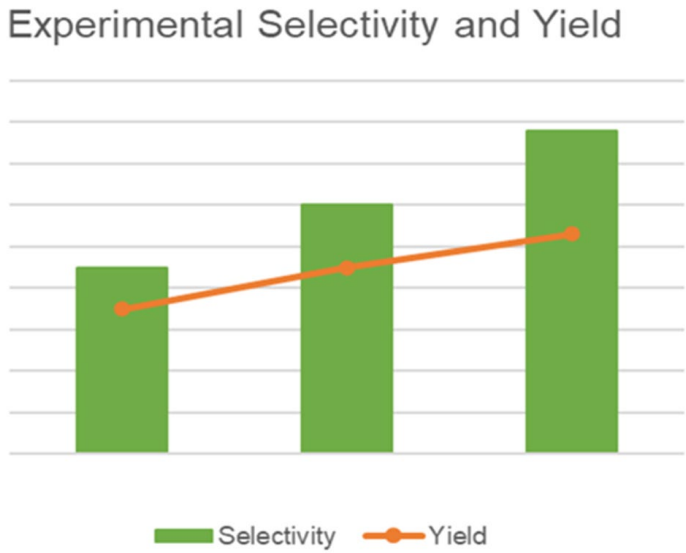
But plotted over 1000 hours

-> “Neither A nor B is good enough!”

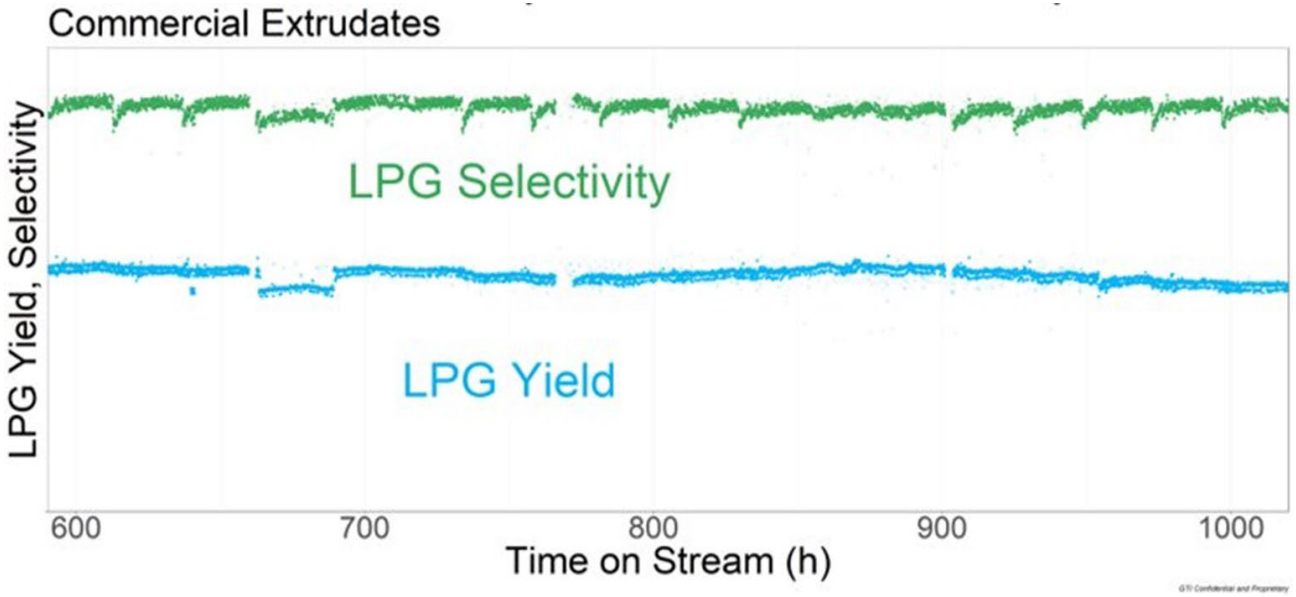
Process and Catalyst Development at GTI Energy



Successive catalyst formulations have been developed over the past 3 years leading to greater stability, activity and yields



Process and Catalyst Development at GTI Energy



Example 1: Stability test over catalyst extrudates

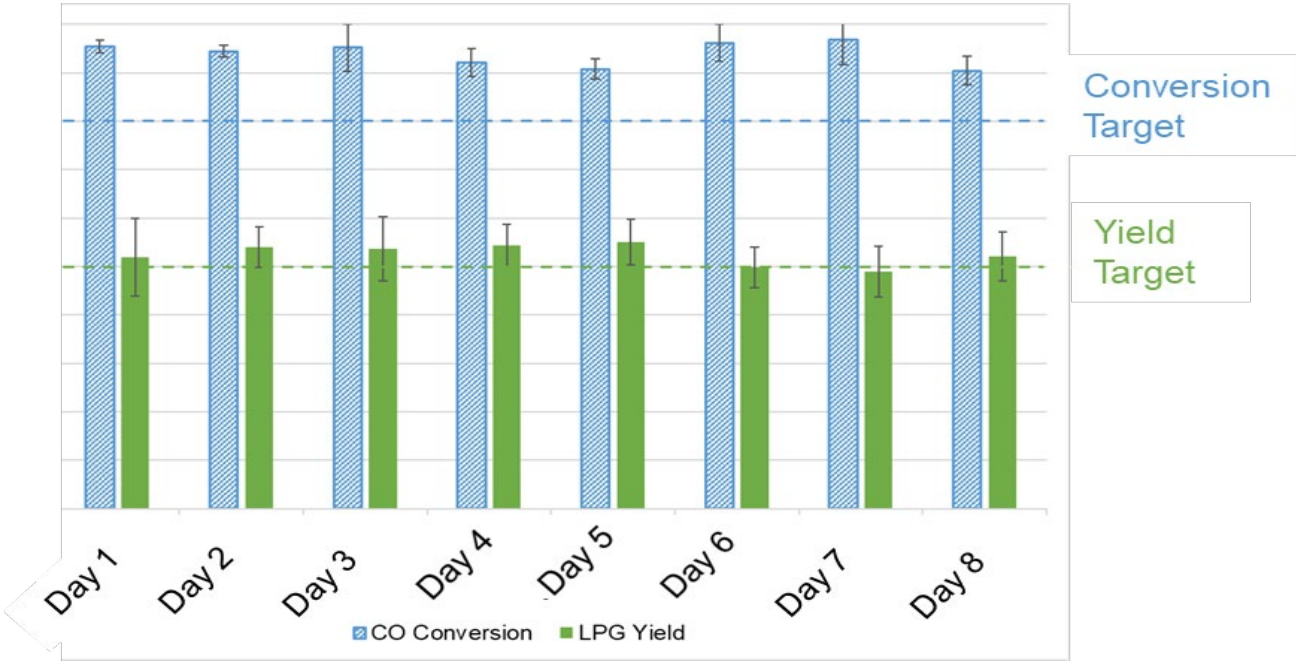
Bench scale testing over commercially obtained extrudates from a catalyst toll manufacturer

No catalyst regeneration performed!

Process and Catalyst Development at GTI Energy

Example 2: Achieving yield and conversion targets for this development phase

Bench scale testing over commercially obtained extrudates from a catalyst toll manufacturer



No catalyst regeneration performed!

LPG Week Global Science Conference

James Rockall, the CEO of WLGA presents **GTI Energy's Dr. Pedro Ortiz-Toral** the award for **best presentation for Cool LPG** at GSC 2023

GSC 2024 will take place on **Friday 22nd November** at the Westin Cape Town South Africa during LPG Week

Operational plant before the end of the decade

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THE GLOBAL LPG PARTNERSHIP

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SUPPORTING INFORMATION

Examples of Commercialized GTI Energy Biomass Conversion Technologies

At TC Biomass 2022, there was one talk on renewable LPG. This year there are at least four.

- **The development landscape has significantly changed over the past 3-4 years**

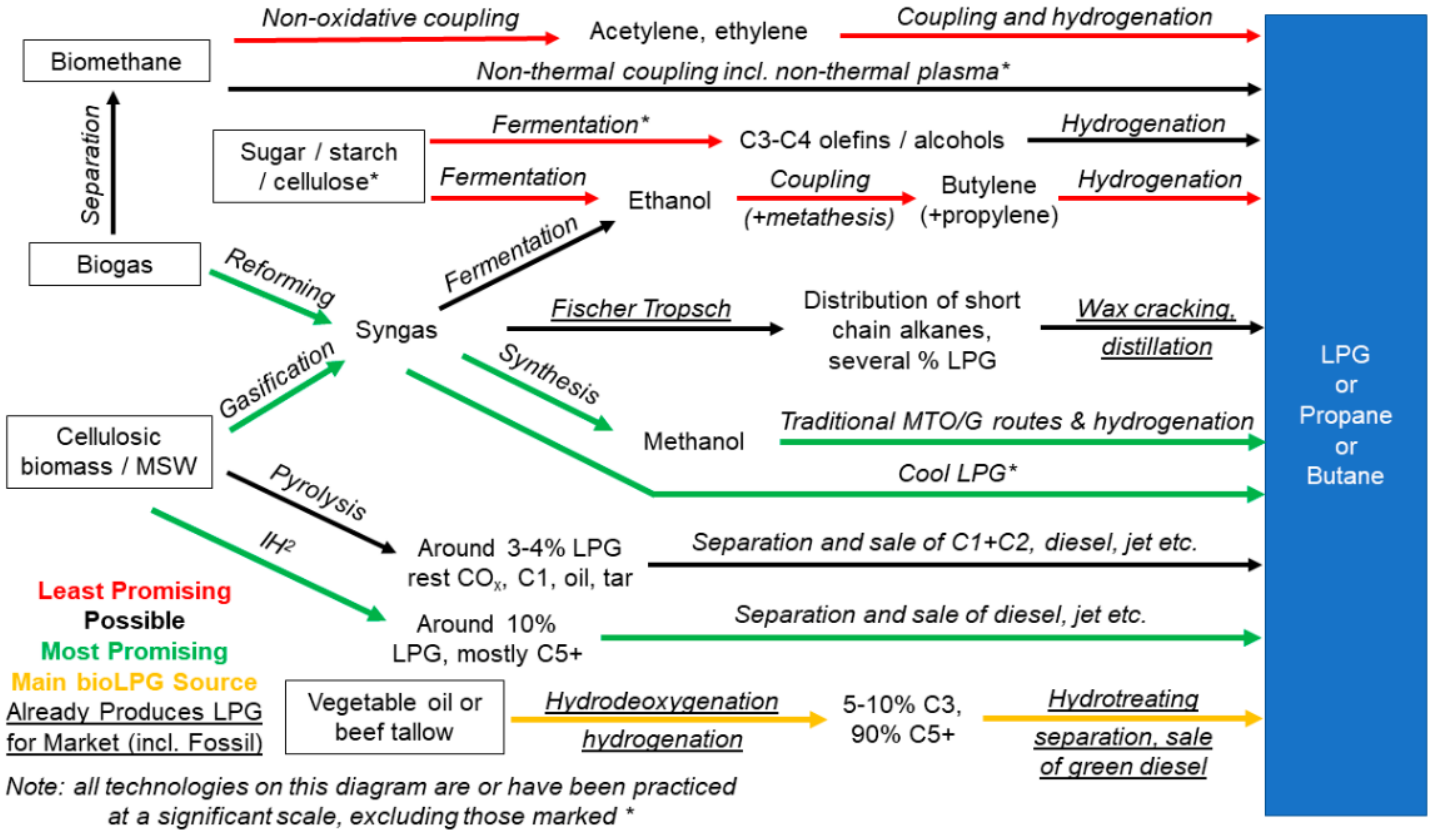

Figure from study performed in 2020

Chen, K. C. *et. al Energies* **2021**, 14, 3916. https://doi.org/10.3390/en14133916

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GTI Energy develops innovative solutions that transform lives, economies, and the environment