



SHV ENERGY
an SHV company

Ethanol to bio-LPG and green aromatics using modified ZSM 5

TC Biomass 2026

Market leader in LPG distribution

4 continents

13,000 employees

21 countries

26 million customers

Our brands


BUTAN PLIN


SUPERGASBRAS


SUPERGAS


PINNACLE


GASPOL


CALOR


SHV ENERGY SUPPLY
& RISK MANAGEMENT


IPRAGAZ


LIQUIGAS


PRIMAGAS


PRIMAGAZ


PETROMAX LPG


PRIMA LNG


PRIMAGAS


EM3
An SHV Energy Company



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 Bangladesh
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 Belgium
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 Bosnia and Herzegovina
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 Brazil
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 Croatia
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 Czech Republic
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 France
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 Germany
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 Great Britain
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 Ireland
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 Italy
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 Luxembourg
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 Northern Ireland
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 Poland
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 Singapore
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 Slovenia
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 Spain
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 Turkey
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 United States of America

Why (bio)LPG matters – 350 Mt/year globally consumed

Comparable in size to the global jet fuel market. Defossilizing this market will require scalable bioLPG production pathways.

Heating

LPG is used in off-grid homes with boilers and heating appliances, in offices and by farmers for heating greenhouses.

Cooking

LPG provides a cleaner energy source for cooking than coal or heating oil, and it can be connected to any home cooking appliance.

Transport

LPG is the world's most popular automotive fuel. Operating under the brand Autogas, it's used in over 25 million vehicles around the globe.



Domestic

LPG provides energy for the home, as well as for a range of leisure activities from BBQ grills to caravanning and mobile catering.

Commercial

LPG is used by commercial customers to reduce their use of higher-carbon, polluting energy sources. In developing countries, LPG replaces hazardous solid fuel used for cooking stoves.

Industrial

LPG is used for a wide range of industrial applications and processes, such as heating, cooling, drying, processing and food production.



Why ethanol? A scalable feedstock for bioLPG

With nearly **100 million tonnes produced annually** and traded worldwide, ethanol offers both the scale and infrastructure required for large-scale bioLPG deployment.

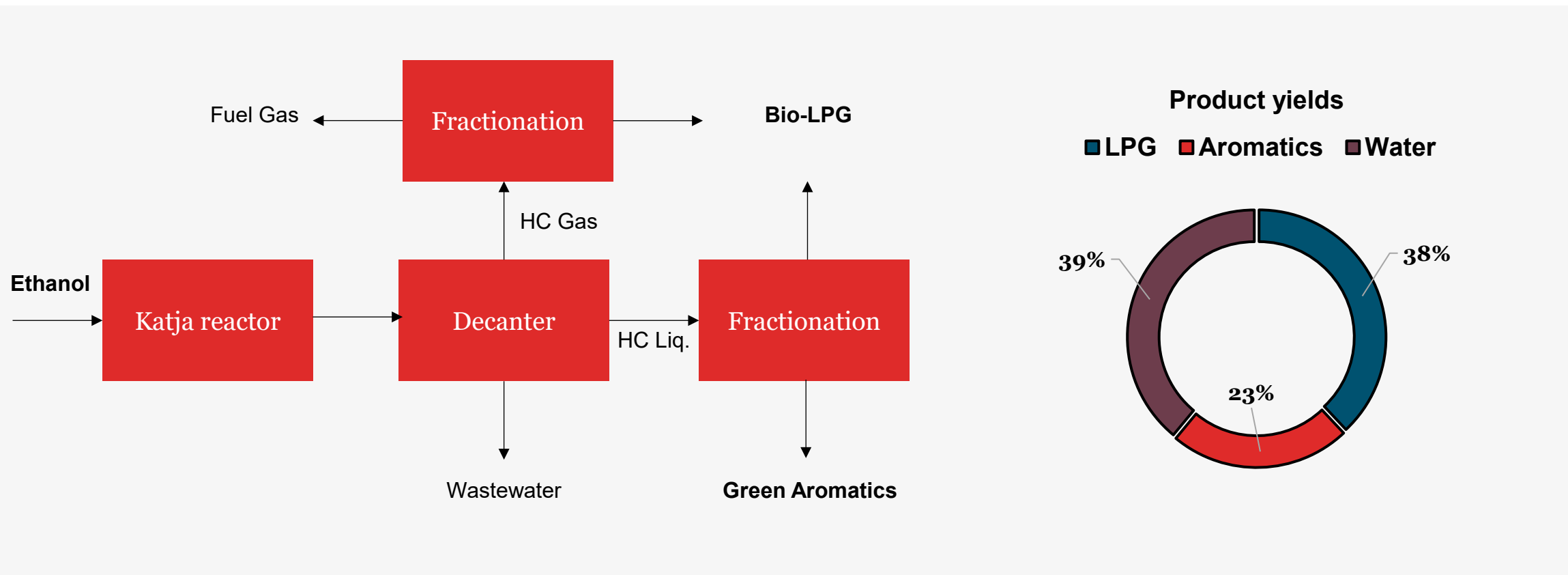


Region	Million Gallons	Million Tonnes	Percentage
US	16,494	49.3	52%
Brazil	8,650	25.8	27%
India	2,600	7.8	8%
EU	1,500	4.5	5%
China	1,030	3.1	3%
Canada	472	1.4	1%
Thailand	390	1.2	1%
Argentina	330	1.0	1%
Rest of the world	534	1.6	2%
Total	32,000	95.6	

Source RFA 2025

Technology: A hydrogen-free pathway to C₃-C₄ paraffins

Bioethanol is converted over modified ZSM-5 **without external green hydrogen** in one single step into > 35 wt% LPG and >20 wt% aromatic compounds, mainly BTX.



Catalyst selection and modification: ZSM 5

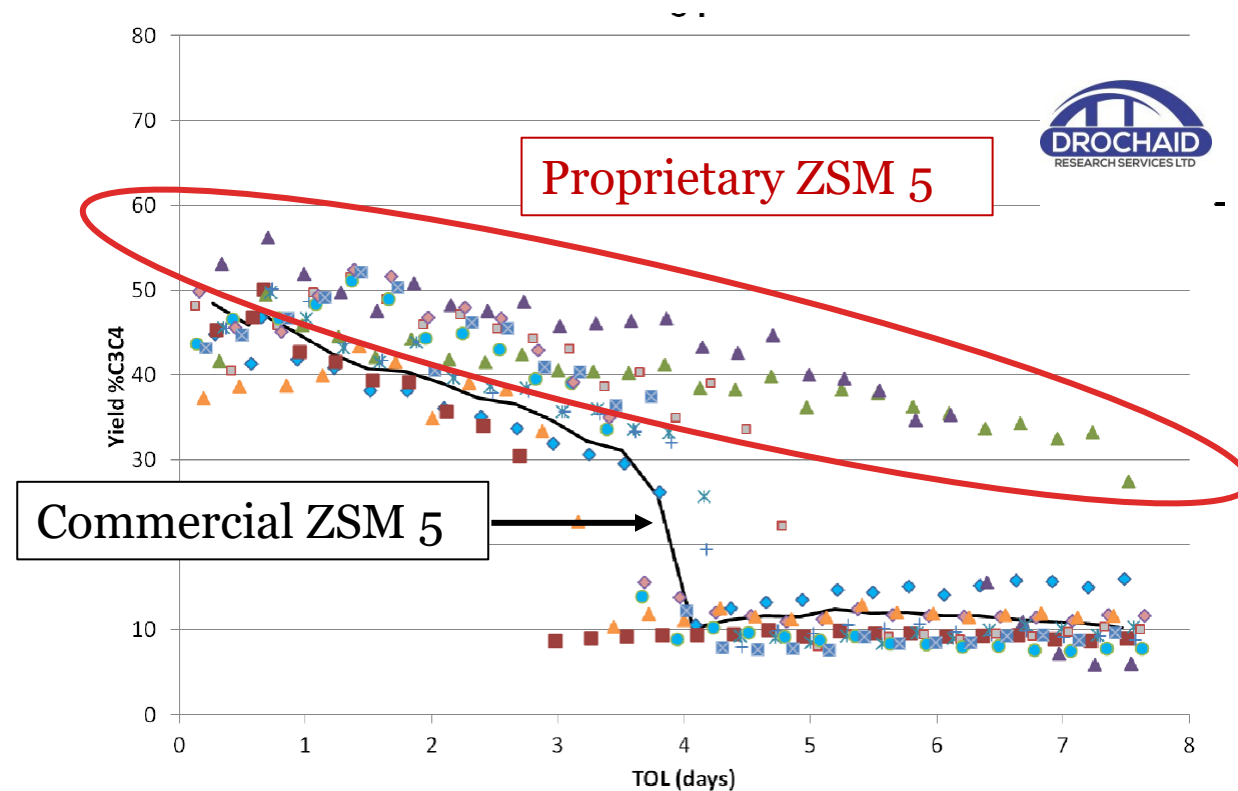
Based on the literature (Methanol-to-Gasoline) H-ZSM 5 was selected as the starting point but not all ZSM-5 catalysts behave equally under ethanol conversion conditions.

- **Commercial H-ZSM 5**

Rapid loss of C_3 - C_4 selectivity observed with commercial catalyst.

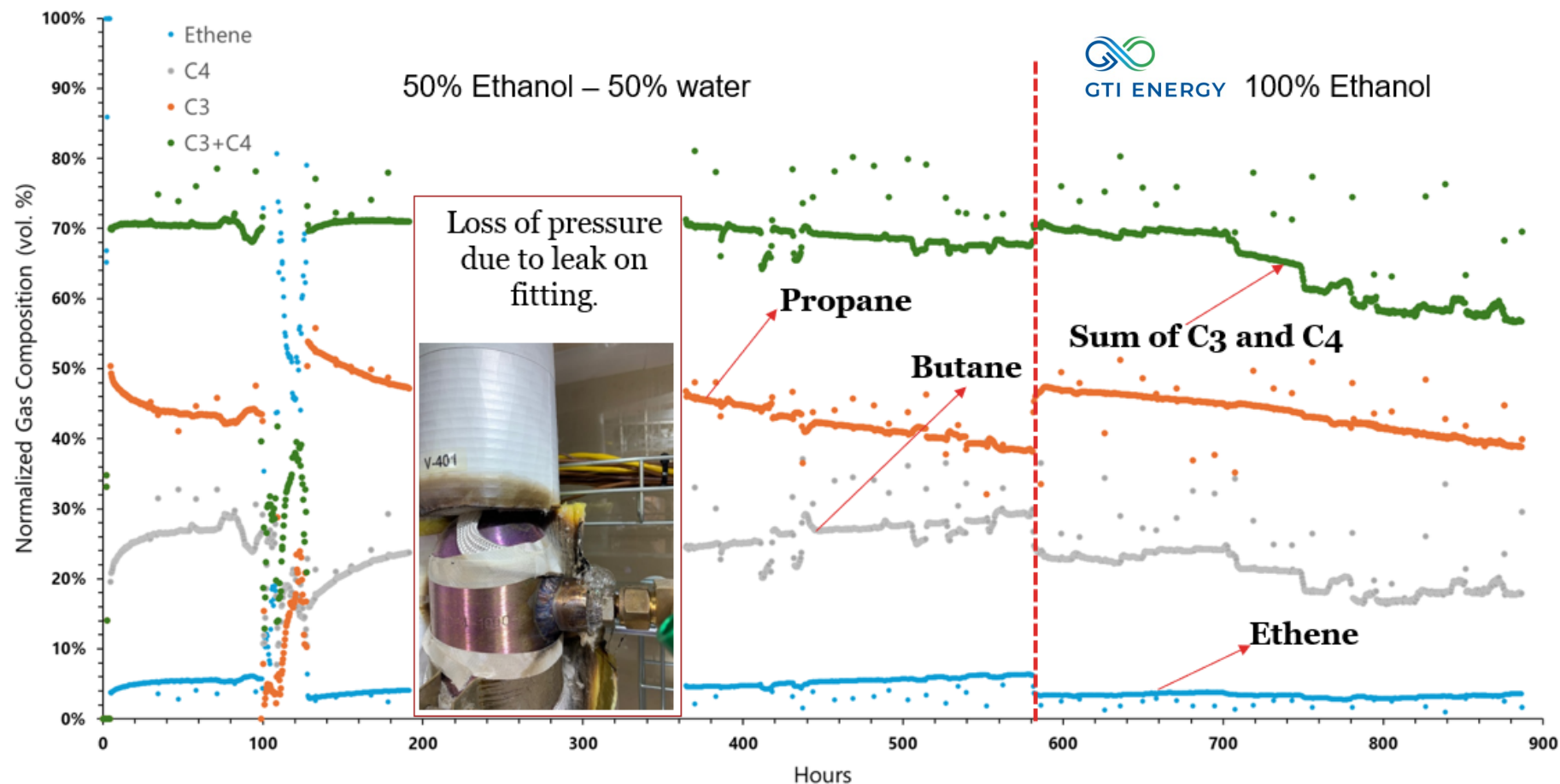
- **Modified ZSM 5**

Modified ZSM-5 increased paraffinic C_3 - C_4 selectivity and maintained performance for more than 4 days.



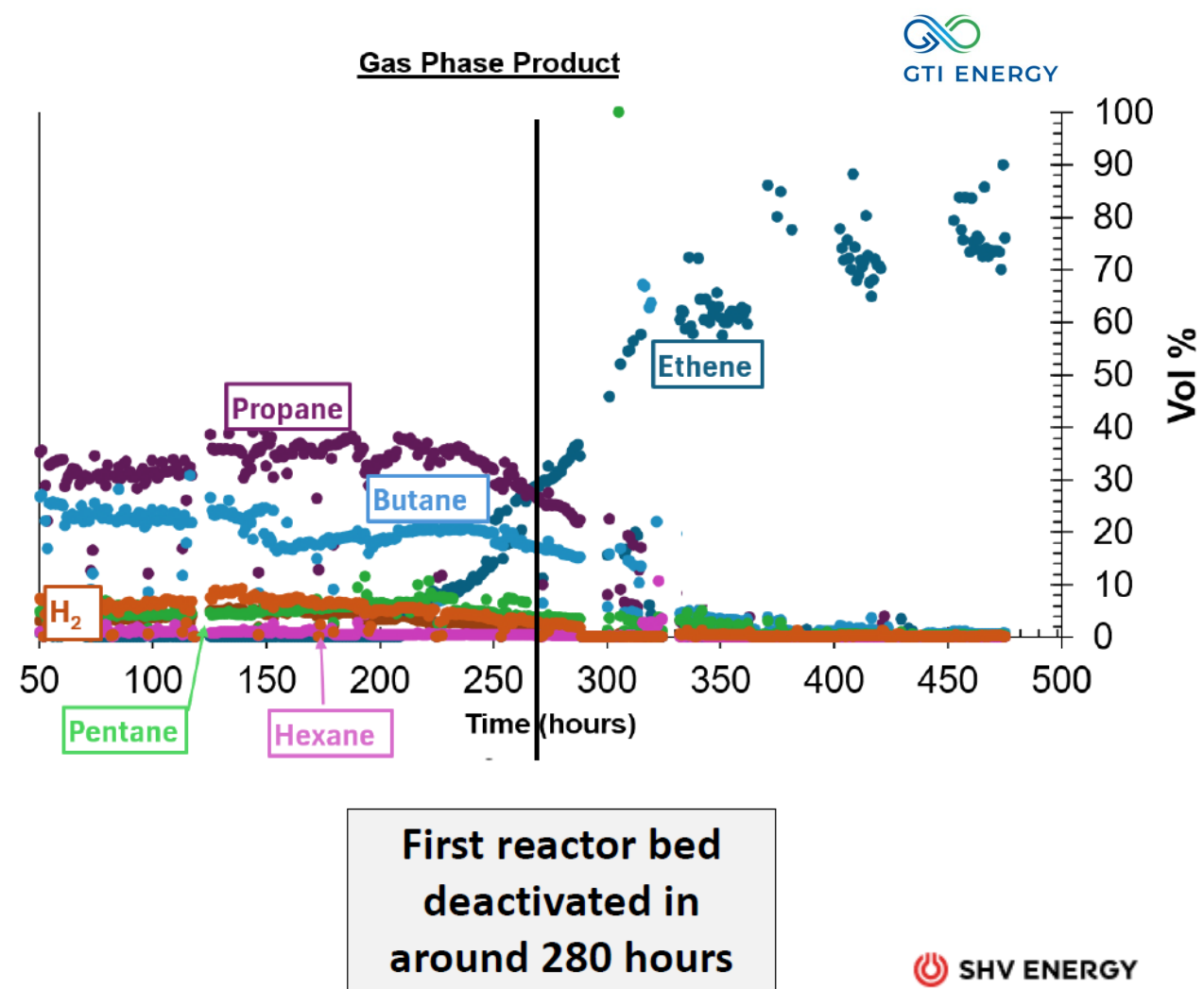
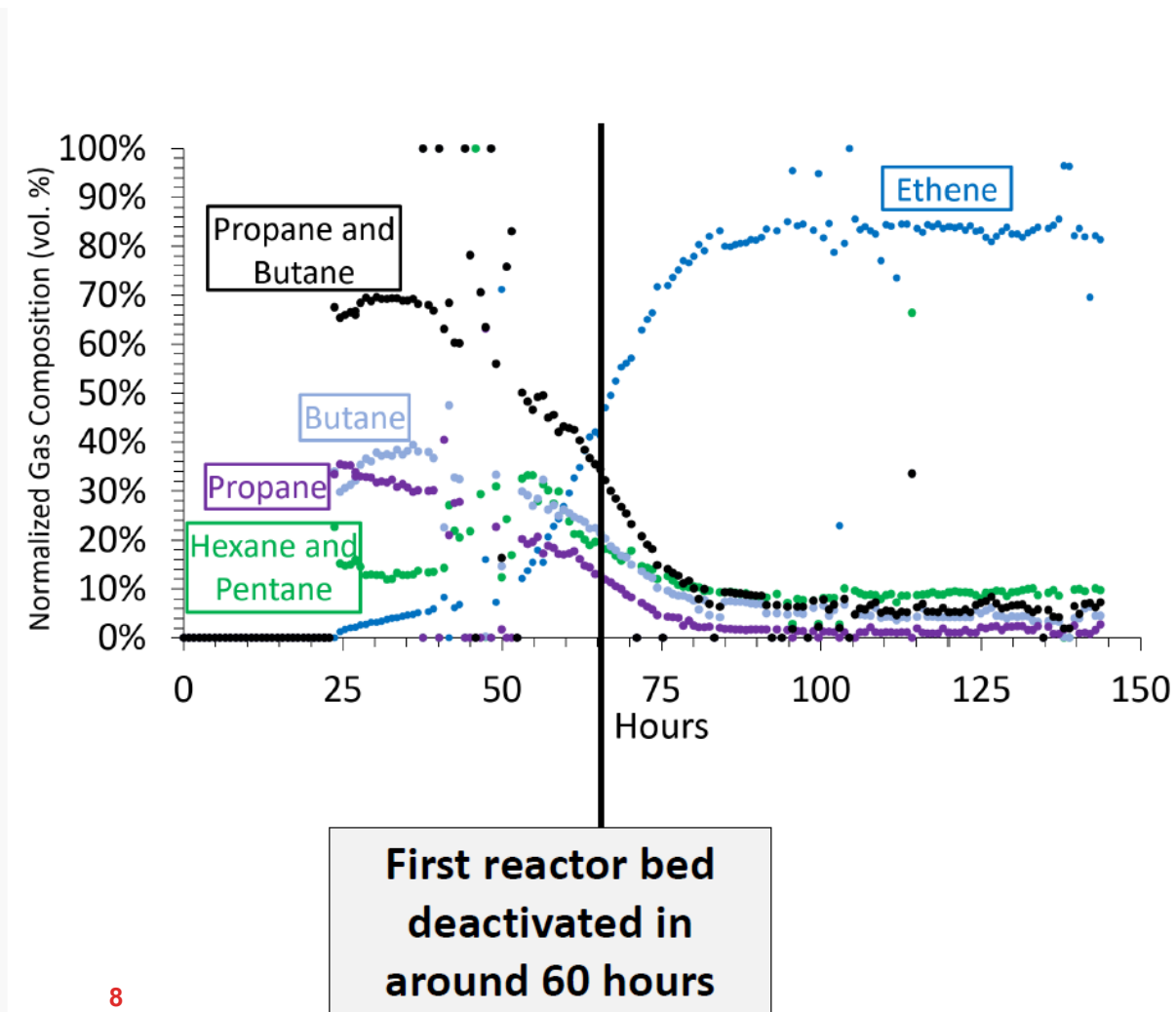
Scale-up evidence: over 900 hours continuous operation

Modified ZSM-5 demonstrated prolonged stability and improved C₃-C₄ paraffin selectivity in a 1-inch reactor.



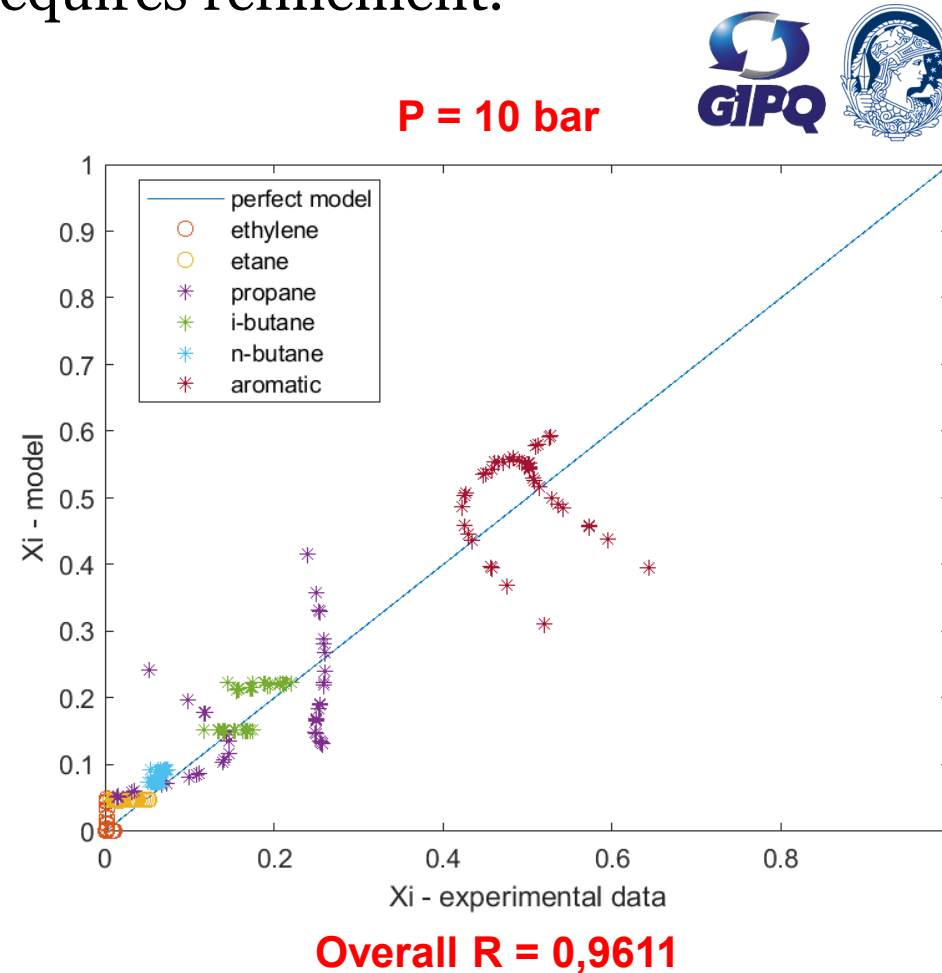
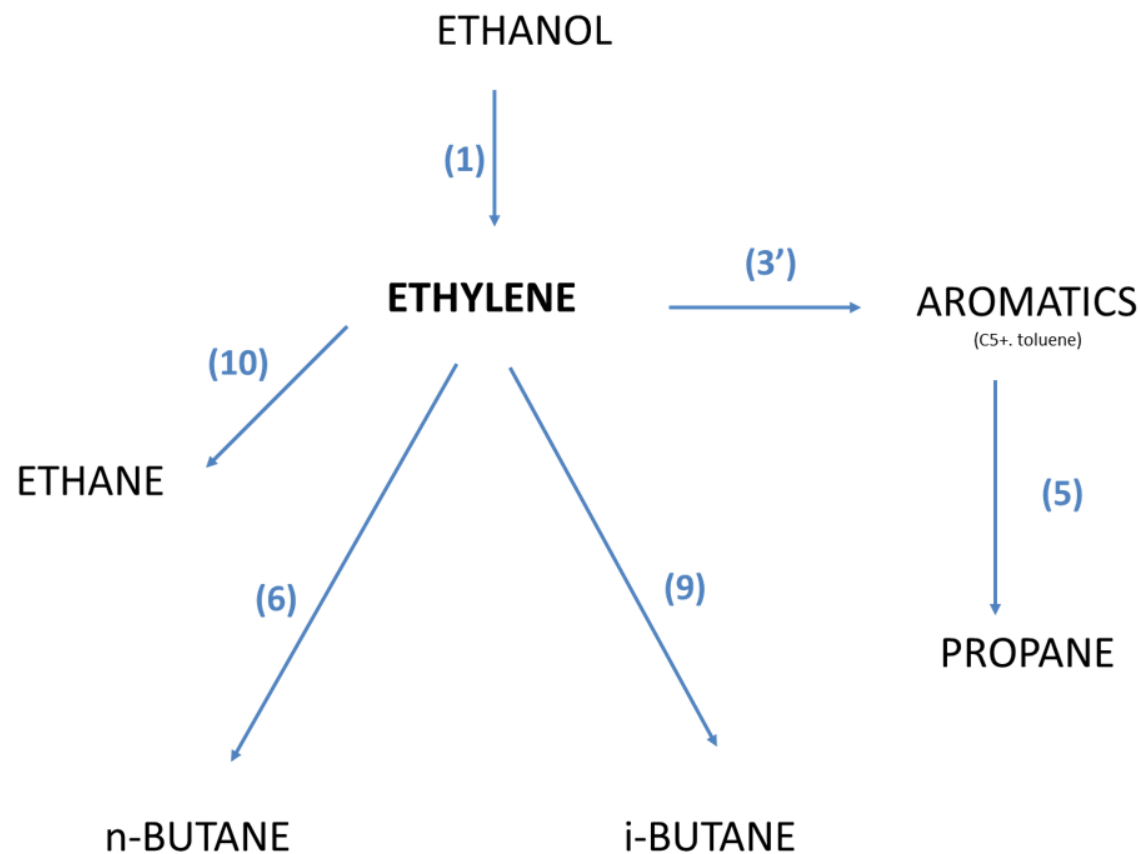
Modified ZSM 5 vs commercial H-ZSM 5

Modified ZSM-5 stability was improved by a factor of 4.6 compared to commercial catalyst with 100% ethanol used as the feedstock.



Understanding the chemistry behind bioLPG formation

Experimental data and reaction pathways were integrated into a first-generation kinetic model that captures the main behaviour but still requires refinement.



Green aromatics improve value proposition

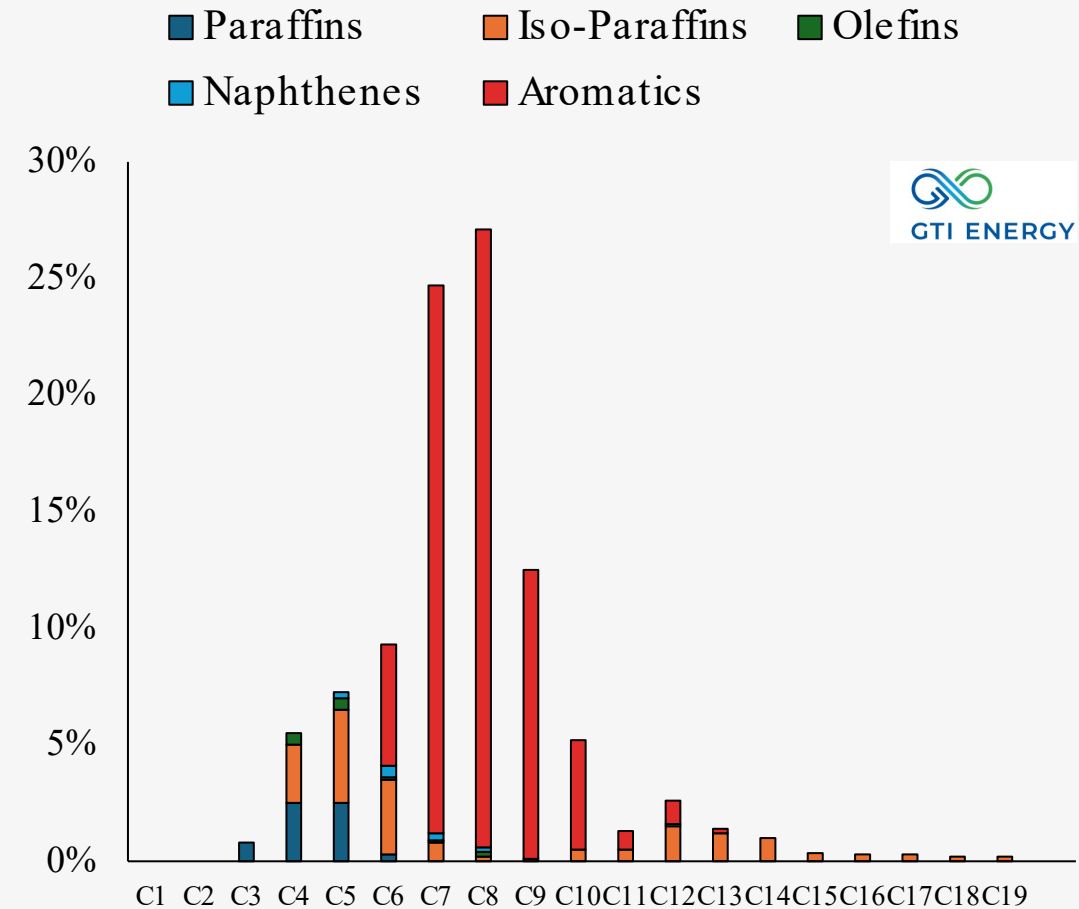
The target product is bioLPG, but green mono-aromatics provide additional value and improve process economics.

- Aromatics as chemicals**

Overall market of 150 million metric tonnes in 2025

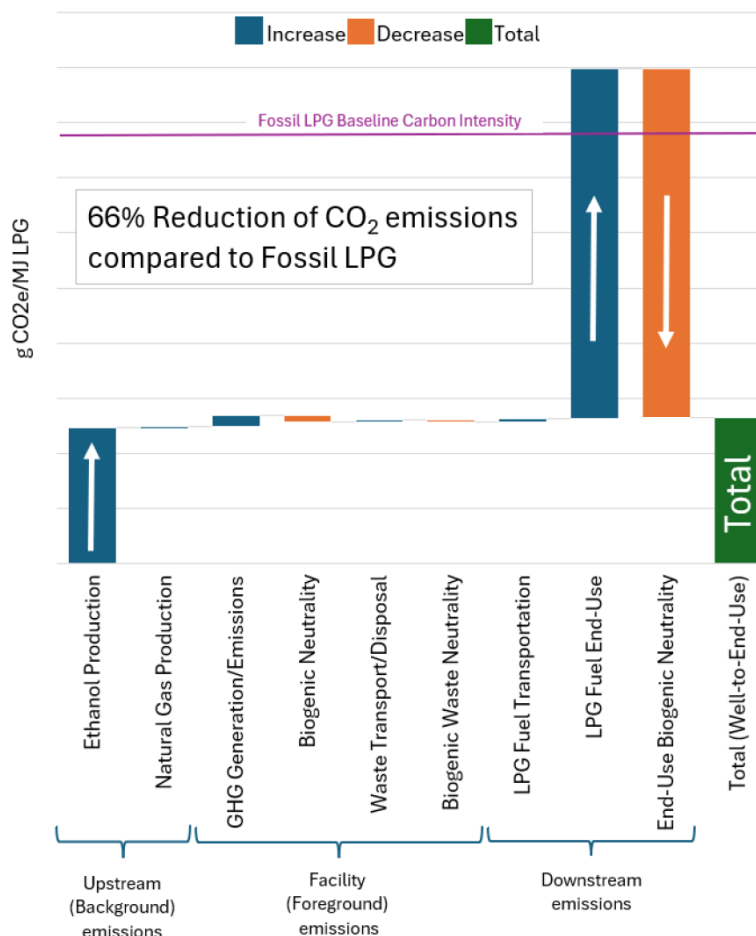
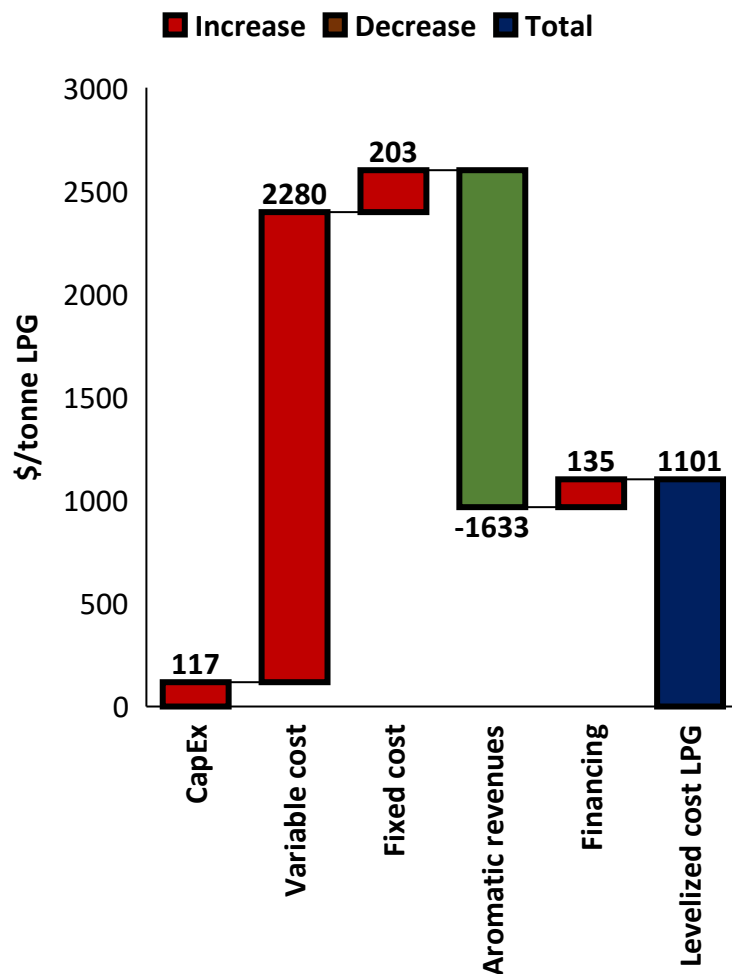
- Aromatics as SAF blending**

Aromatics are an essential component to conventional jet fuel to prevent leaks



Competitive cost at significant lower CO₂ emissions

TEA indicates around 1,200 USD/MT bioLPG and around 70% GHG reduction potential.



Techno-economics

Potential levelized cost of 1100 \$/tonne (excluding inflation, 20-year project), implying an off-take price of 1200 \$/tonne LPG at 15% IRR.

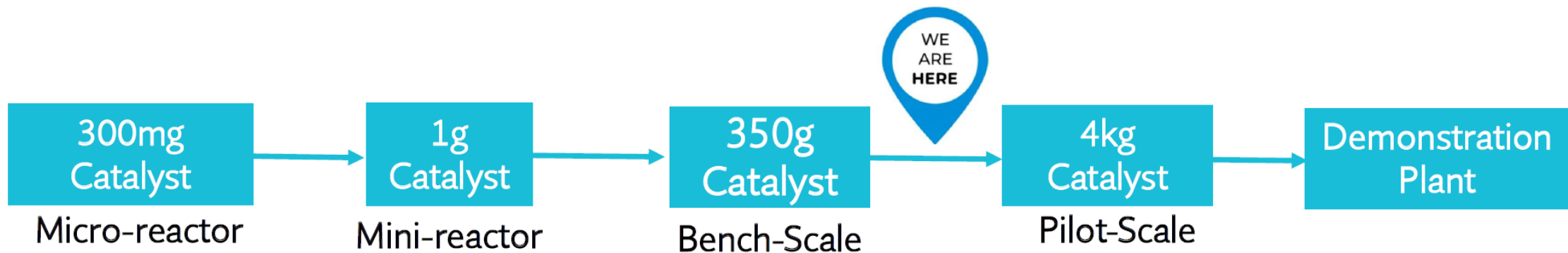
Life Cycle Assessment

GHG emissions reduction between 65 – 75% compared to fossil LPG, depending on ethanol carbon intensity.

Bridging the gap to commercial deployment

Further development will require a consortium of industrial, technology and financial partners to support pilot-scale validation and commercialisation activities.

-  Ethanol concentration tested from 50 to 100 wt% (> 900 hours)
-  Ethanol to fuels energy efficiency ~ 50%
-  Cost-competitive: bio-LPG (1200 \$/MT) & SAF blending (47 \$/GJ)
-  Technology is at TRL 4, ready to scale up for pilot plant





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Join us in bringing ethanol-to-bioLPG to pilot scale



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