BIOENERGY ASSOCIATION

webinar series

Decarbonising LPG

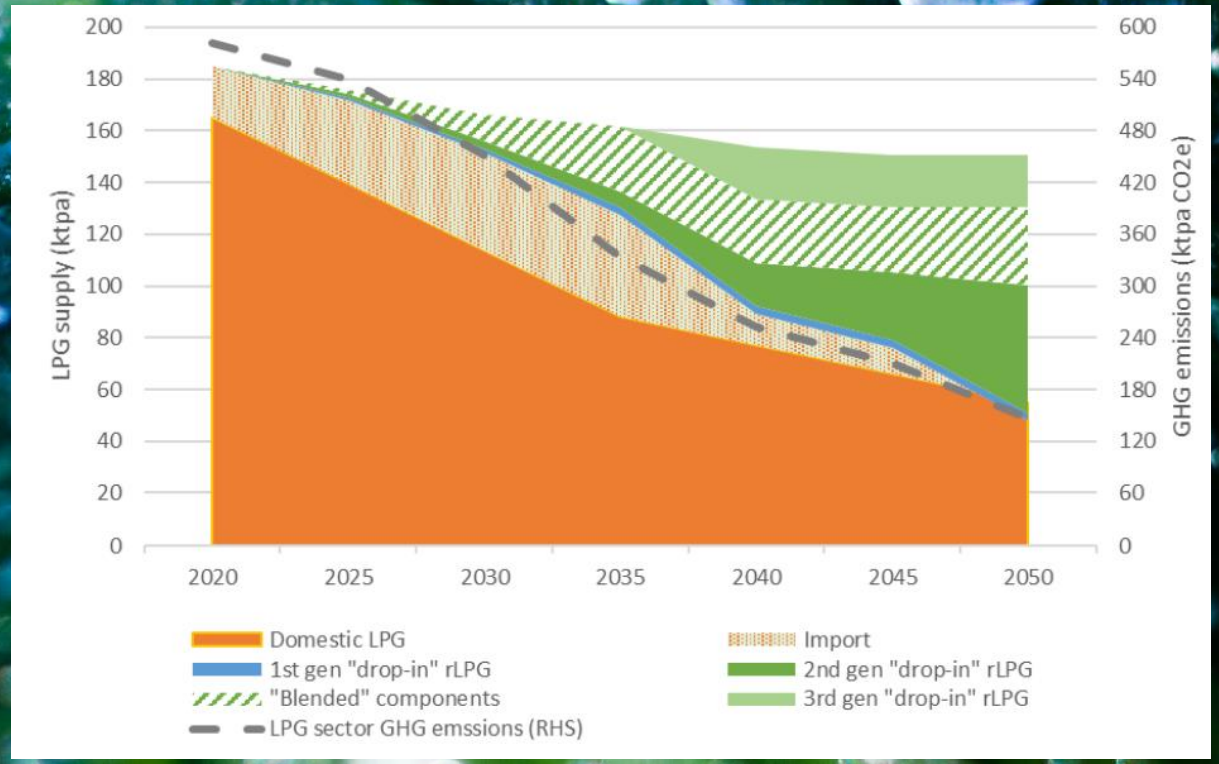
Next steps in the roadmap for LPG in New Zealand

Albert de Geest
22 February 2022

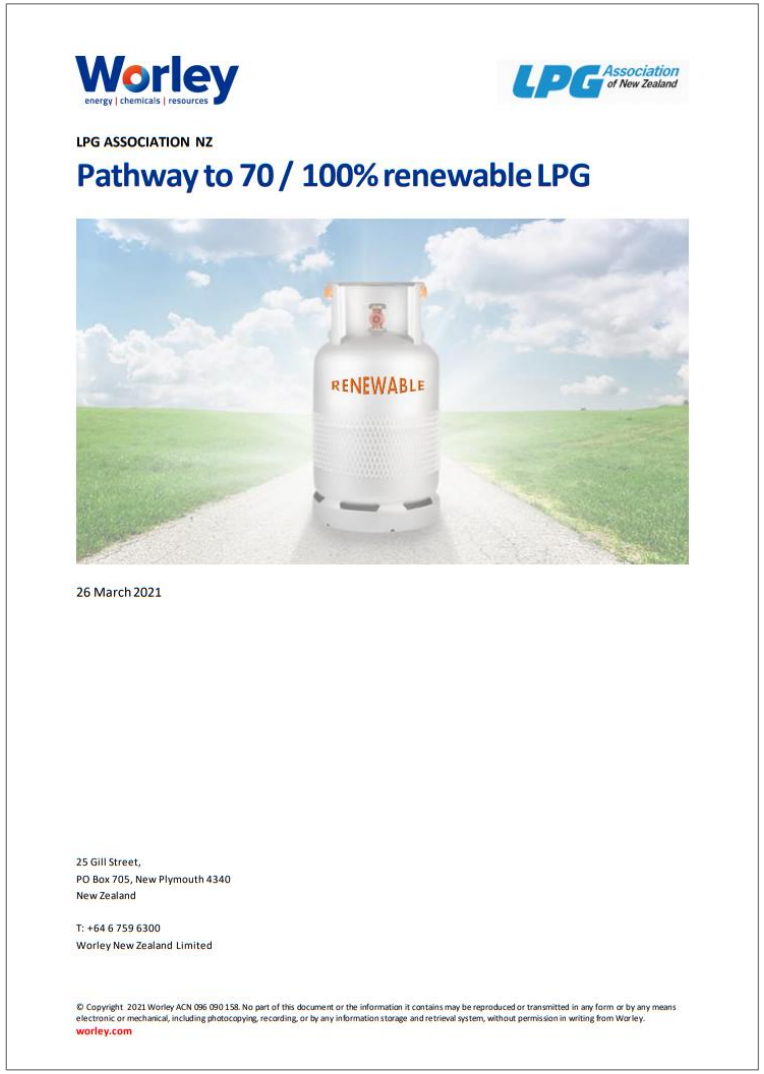
Can we decarbonise LPG?

Annual Demand **193,000 mt (9.5PJ)**
Annual Production **165,000 mt**
Customer Installations **178,000**

Industrial volume ≈ 31%
Commercial volume ≈ 20%
Residential volume ≈ 38%
Portable volume ≈ 11%



Two Reports



LPG ASSOCIATION NZ

Pathway to 70 / 100% renewable LPG

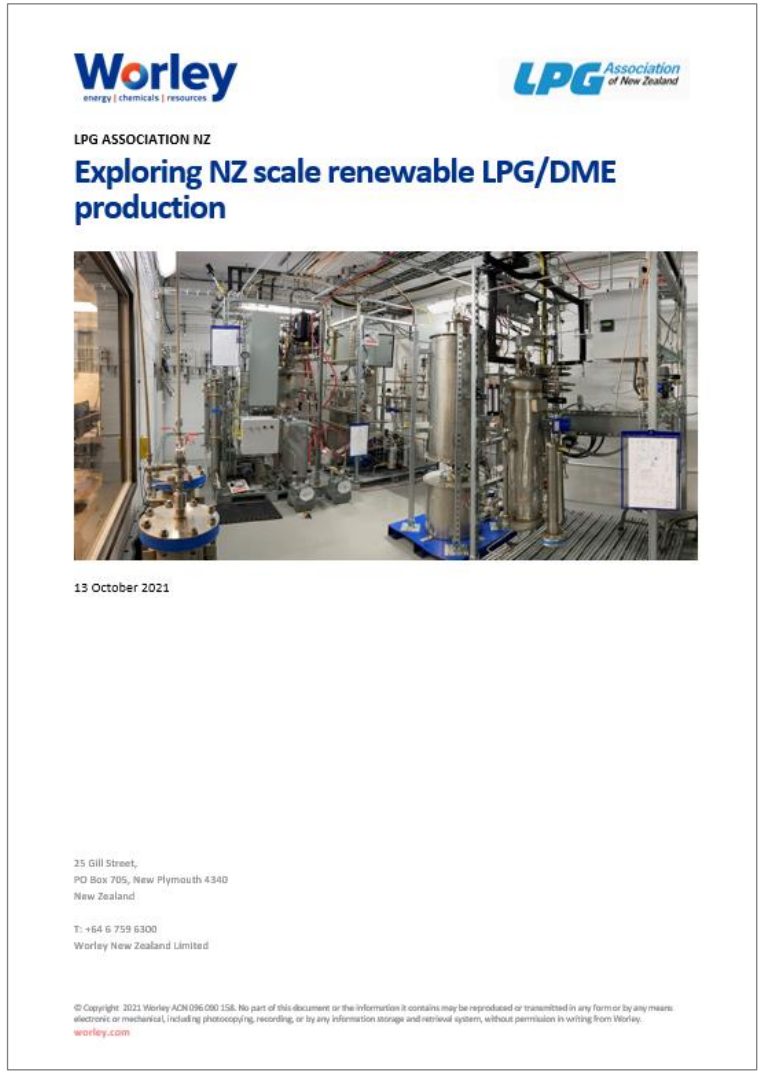
26 March 2021

25 Gill Street,
PO Box 705, New Plymouth 4340
New Zealand

T: +64 6 759 6300
Worley New Zealand Limited

Synopsis

This study explores the appropriate journey for decarbonisation of the New Zealand LPG sector, and demonstrates that maintaining existing LPG distribution assets and progressively displacing conventional LPG with renewable LPG can support growth of a biofuels industry whilst supporting jobs, fuel security and energy supply diversity.



LPG ASSOCIATION NZ

Exploring NZ scale renewable LPG/DME production

13 October 2021

25 Gill Street,
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Worley New Zealand Limited

Synopsis

This study extends the findings of the "Pathway to 70/100% rLPG renewable LPG" report by more deeply exploring second generation pathway for the production of renewable LPG / DME at NZ scale.

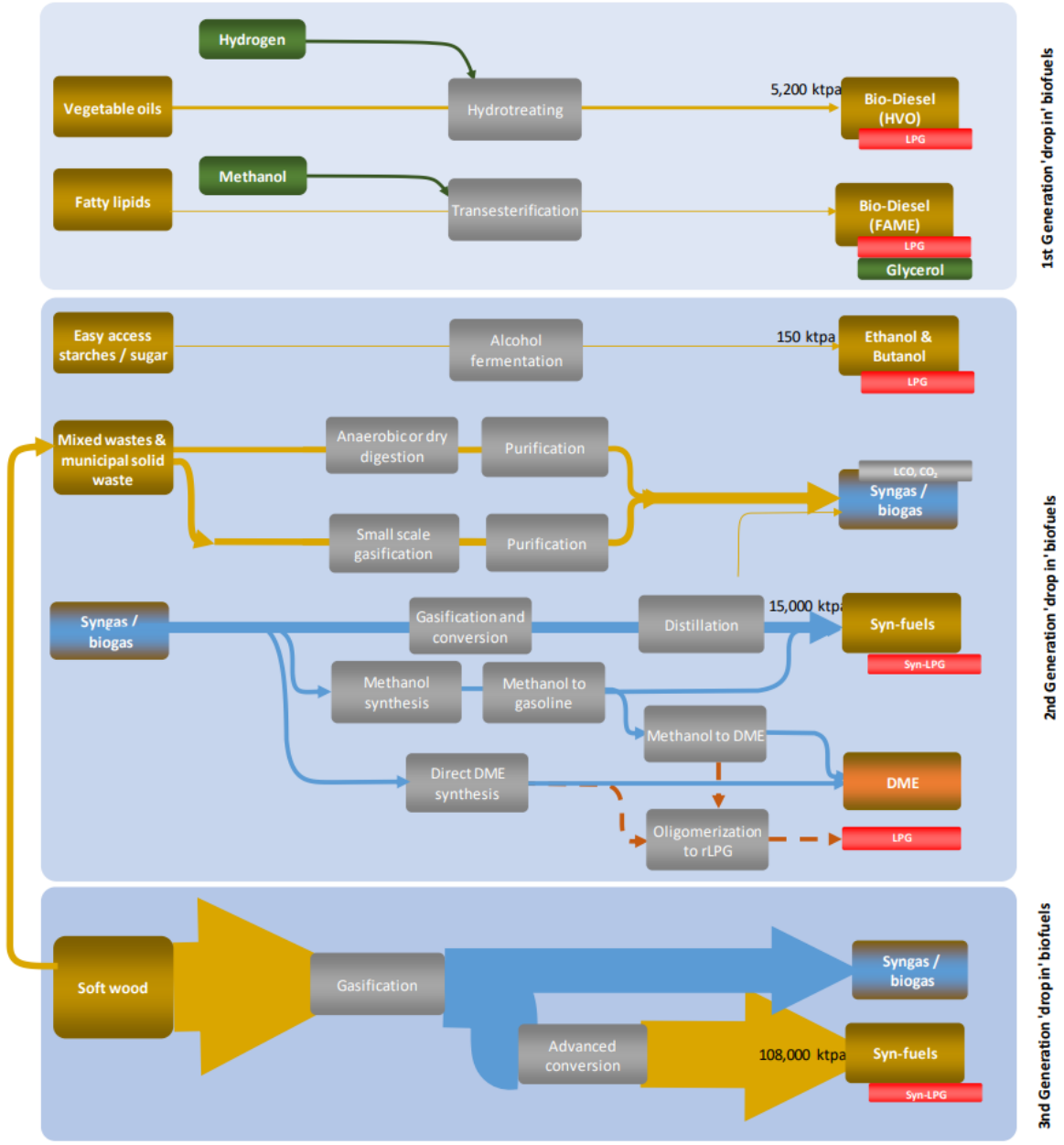
First Report

The development of a renewable LPG industry appears to be possible …

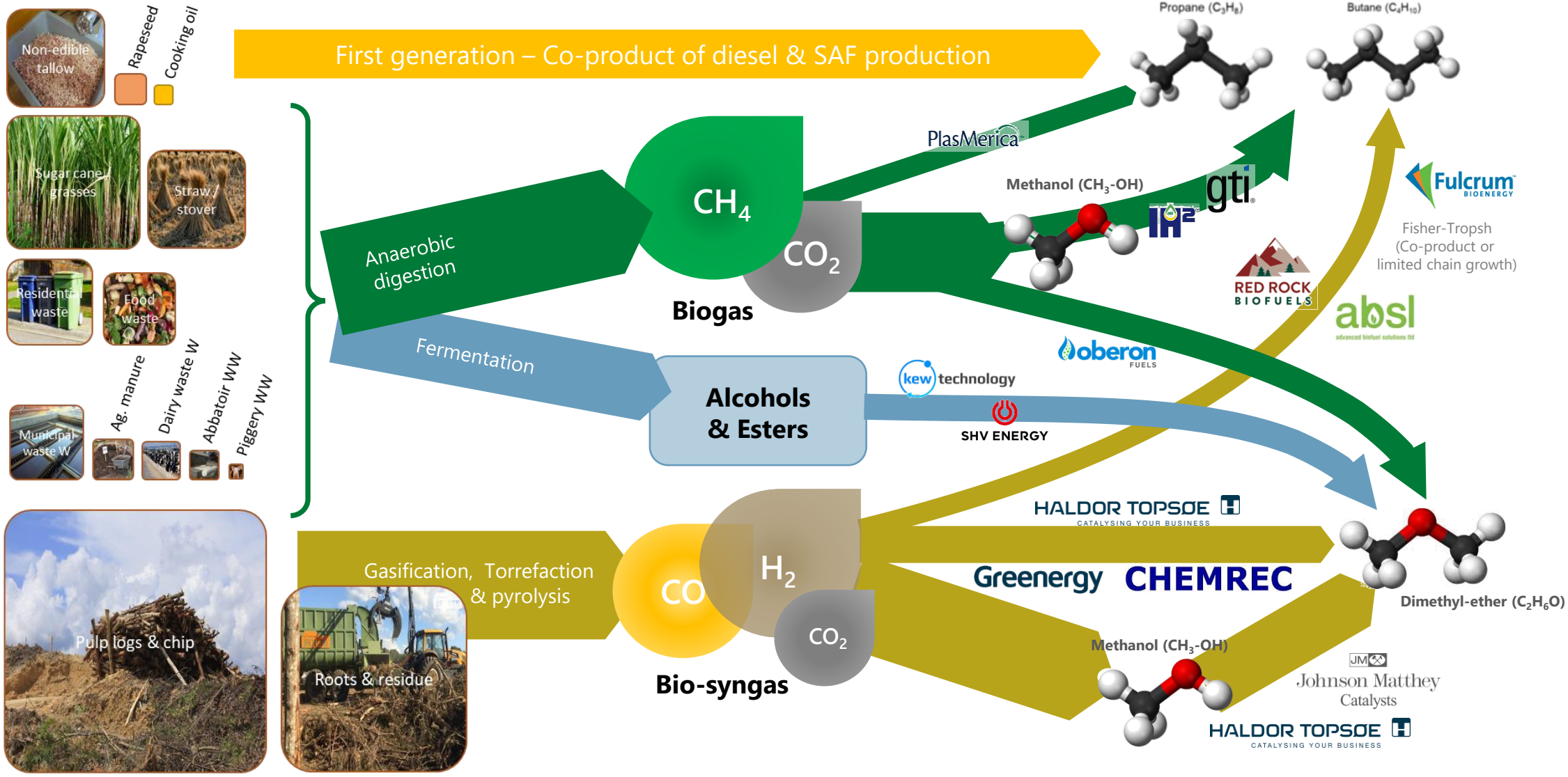
- Minimal 1st generation
  - rLPG is generally a co-product of waste to fuel developments – Minimal risk, but low volume;
  - Already significant volumes worldwide, but none in New Zealand

- Emerging developments in 2nd generation open real opportunities

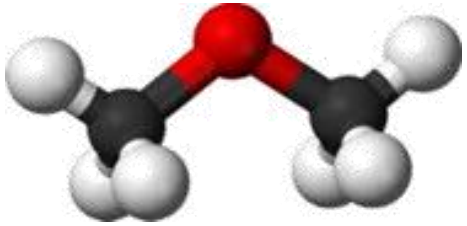
- 3rd generation has always had promise, but larger scale and higher risk
  - Will most likely proceed with rLPG as a co-product in the production of liquid fuels



Pathway Summary



Dimethyl-ether (C_2H_6O)



What is renewable DME?

A simple product

Dimethyl-ether is **a single molecule** that can be produced from a **wide range of renewable feedstocks.**

Easy to handle

DME is **chemically similar to propane and butane,** and is a gas at room temperature and pressure. Like LPG it is easily transported as a liquid in pressurised cylinders and tanks.

Safe, clean and green

rDME **can reduce GHG emissions** by up to 85% compared to diesel and heating oil. Its use also significantly improves air quality.

Numerous applications

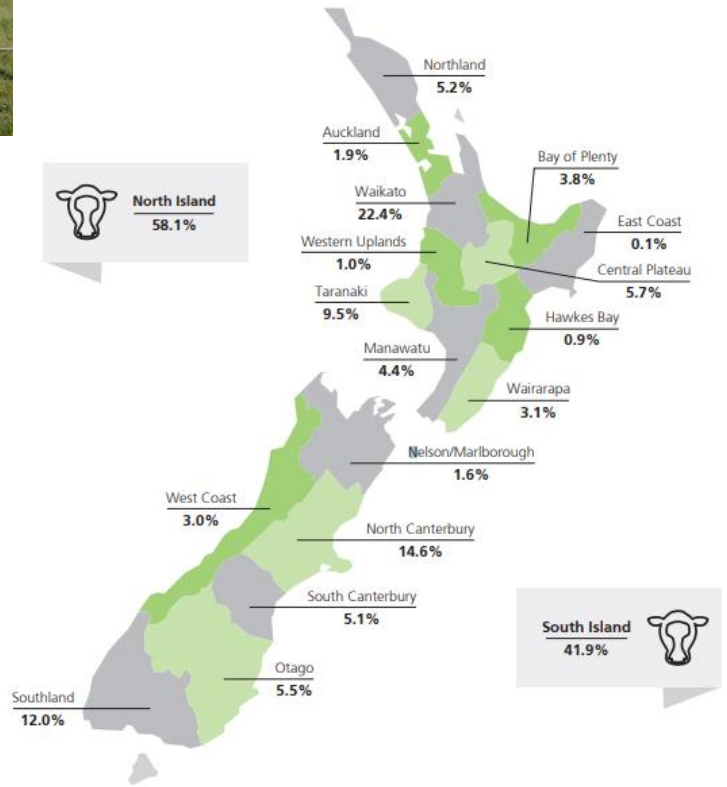
DME has been used **for over 50 years in the chemicals sector** as an aerosol propellant. It can also be used in the transport sector, for cooking, as well as domestic and industrial heating.

- Produced from a wide range of sustainable feedstocks
- Blended up to 20% with LPG can be used in existing domestic heating and cooking appliances
- Can be used as a 100% renewable fuel or in an rDME/LPG blend in industrial applications
- Has been used as a replacement for diesel in heavy transport
- Can be used as a hydrogen carrier
  - A litre of liquid DME contains more hydrogen than a litre of liquid hydrogen

Biogas for 2nd Generation Pathways

Dairy manure / waste water scale

- Average farm size 440 cows on 155 hectares
- 35 kg/cow/day but only 8% recovered
- Challenging to create large farming collectives
- 20,000 cows yields ~1,500 Sm^3/day of biogas (1,000 kg/day methane)
- Up to 30% uplift for AD + HRAP systems



Key digestion technologies

- Anaerobic digestion only (AD)
- Anaerobic digestion with High-rate algal ponds (HRAP)
- Dry digestion

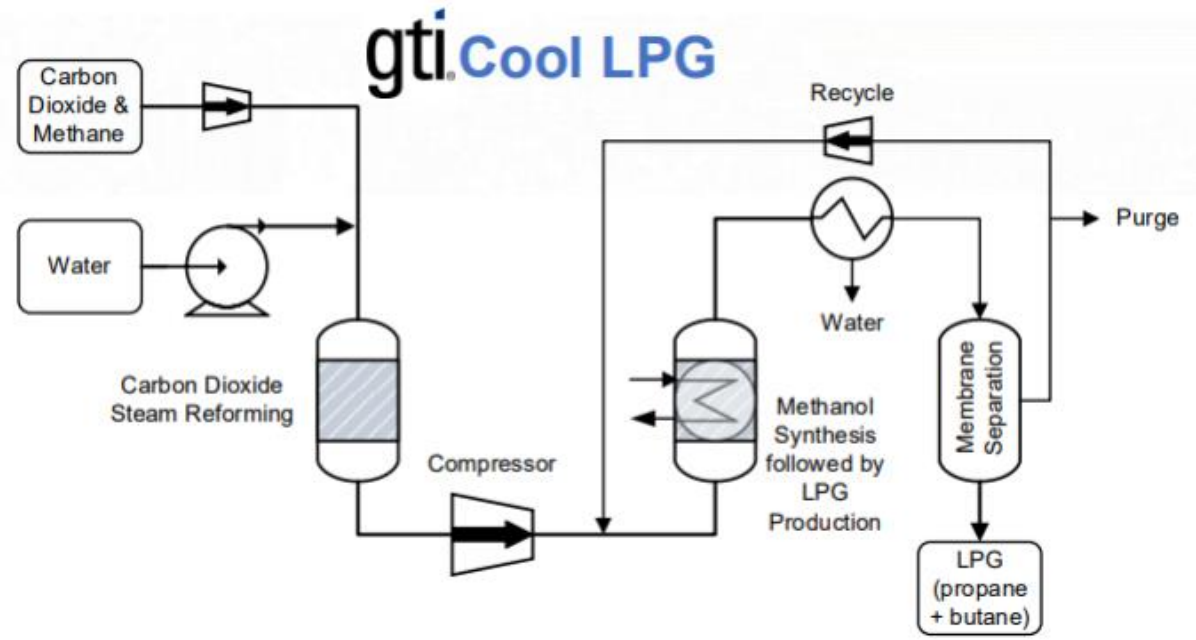
Municipal wastewater scale

- Significantly greater scales are possible e.g. 100,000 population yields ~25,000 m^3/day wastewater which yields ~4,500 Sm^3/day of biogas (3,150 kg/day methane)
- Ecogas Reporoa collects 75 ktpa food waste to yield 24,000 Sm^3/day of biogas (16,000 kg/day methane)
- Often securing long-term access to resources challenging and subject to "regional" decision making

Abattoir wastewater scale

- Moderately concentrated resource
- A larger abattoir can yield ~8,000 m^3/day wastewater, which yields ~1,200 Sm^3/day of biogas (810 kg/day methane)

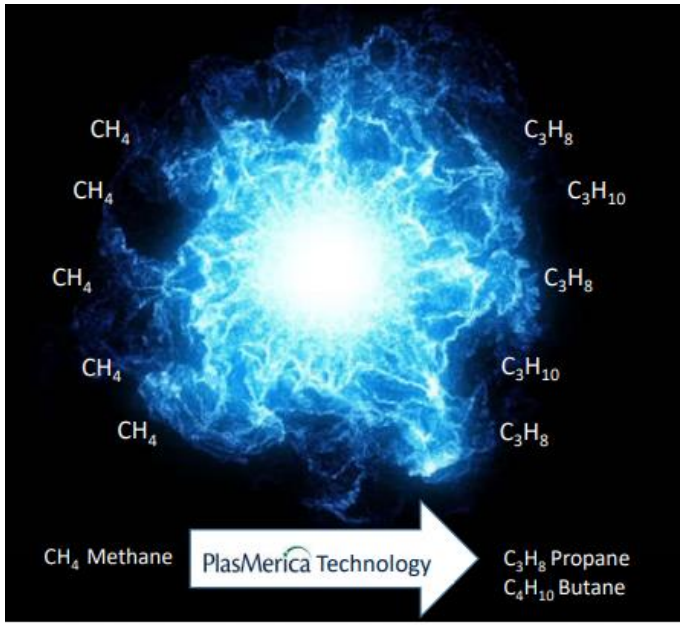
Novel Renewable LPG Production Technologies



Gas Technology Institute

- Significant capability and technology development history e.g., Cool GTL and IH^2
- Direct use of biogas - no upgrading to biomethane required
- This is a methanol mediated reaction

PlasMerica™



PlasMerica

- Small business with agile mindset
- Converting "stranded" methane directly to LPG
- Using non-thermal plasma technology

Both players are interesting but are still only at lab scale …

A Plant for New Zealand

Renewable LPG

- GTI looks most promising
  - Good company with a proven track record
  - Interesting licensing arrangement with BioLPG LLC
  - Targeting larger lab scale next year
    - Increase from 10 to 40 kg/day rLPG
  - Have an electric reformer
    - Piloting 1 ton/day biogas capacity
- Plasmerica
  - Small company, no track record
  - Technology is ideally suited for very small-scale developments with access to renewable power
- Shell IH^2
  - Developed by GTI licensed to Shell
  - 5 tpd plant nearing operation in India
  - Targeting scale of 2,000 tpd
  - Focus is on gasoline but can produce up to 50% rLPG
- Too early to choose a winner
- Realistically 2-3 years away

Renewable DME

- Oberon are demonstrating biogas from manure to rDME technology in California
- Haldor-Topsoe have direct syngas to DME technology
- rDME gaining traction in Europe
  - SHV/KEW targeting 50 ktpa rDME from MSW by 2022
  - Pathway to DME from methanol is well established with many technology providers
  - Pathway direct to DME is less mature, historically never gone past pilot
    - Might pick up with the global interest in DME
- Both gasification and syngas to DME technologies are mature
- Blending rDME into the LPG pool for general use will require us to overcome some additional regulatory hurdles

Regulatory Challenges

General Regulatory Issues

1. General policy framework to drive the development of biogases
   - Part of the "Gas Transition"
   - Work with officials and the GIC on a biogas mandate which will include rLPG and rDME
   - Similar to the liquid biofuels mandate
   - To drive the decarbonisation of gaseous fuels by 2050
2. The calculation of carbon intensity (CI) for both rLPG and rDME with various feedstocks and processes
   - Most current analyses use methodologies developed by CARB but this is not a given
   - Requires urgent attention

Specific DME Issues

1. Current LPG regulations do not allow for blending of DME
2. Blends of up to 20% DME have proven safe in use in Asia and elsewhere, however:
   - Significant testing of both new and old appliances across the range will be required to prove to regulators here that it is safe
   - Regulatory changes, including product specifications will be required to cover blending
3. These are worldwide issues and associations across UK, Europe, New Zealand and Australia have agreed to work together to resolve them

The Future

- Increasing competition for feedstocks with producers of higher order liquid fuels (e.g., diesel, SAF) or lower order utilities (e.g., electricity, heat)
- Securing sufficient feedstocks for a longer term is more of a challenge in New Zealand
- Technology development is also a competitive landscape – funding, talent and market access
- Immediate regulatory hurdles to overcome
- Beyond 2nd generation there is significant scope for the production of rLPG as a co-product in partnership with producers of higher order liquid fuels

Partnerships and persistence are (still) the keys to making a breakthrough for New Zealand

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Safe and reliable LPG infrastructure services

Find out how gas energy will play a vital part in New Zealand's renewable energy future