



# A blueprint for Sustainable Aviation Fuel (SAF) production in South Africa

Farai Chireshe | WWF South Africa

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# ACKNOWLEDGMENTS

The analysis presented here has been conducted by:

Techno-economic modelling of SAF production pathways: Prof. Johann Görgens, Dr. Abdul Petersen and Mr. Farai Chireshe, Stellenbosch University's Department of Chemical Engineering

IAP availability assessment: Prof. William Stafford, Prof. David Le Maitre, Mr. Greg Forsyth and Dr. Ryan Blanchard from the Centre of Industrial and Scientific Research (CSIR)

Network optimisation and costing: Ms. Avania Ravinath, Ms. Lerato Mnyakeni, Mr. Geoffrey Ellis and Ms. Hannelie Viljoen, Imperial Logistics

Socio-economic impacts: Ms. Xolile Msimanga, Ms. Joanne Calitz, Dr. Jared Wright, Mr. Ruan Fourie, Ms Esther Mkhwebane, and Ms. Aradhna Pandarum, CSIR Energy Centre

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# Interplay of aviation and climate in South Africa

Civil aviation related emissions account for more than **8%** of total transport CO<sub>2</sub> emissions in South Africa.

In April 2022, the infrastructure damage caused by severe flooding led to disruptions in the supply of jet fuel and caused interruptions in flight operations.

OR Tambo Airport (Johannesburg) highest air passenger CO<sub>2</sub> emissions in Africa by departure<sup>1</sup>.

Long-haul tourism could be impacted as more travellers become climate conscious.

Transport related emissions will reduce competitiveness of SA exports (EU's Carbon Boarder Adjustment Mechanism – CBAM).

<sup>1</sup><https://airporttracker.org/>

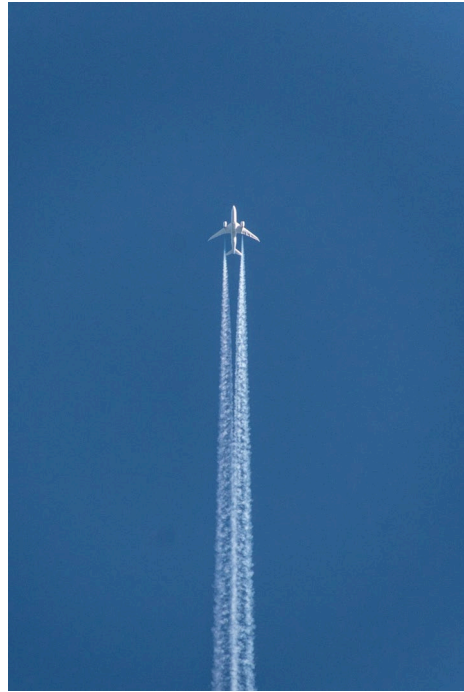


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# Why should SA pursue Sustainable Aviation Fuel (SAF)?



Need to start decarbonising aviation sector



Excellent resource base



Long-standing experience with promising SAF production technologies (**Sasol** and **PetroSA**)



SAF represents an important export opportunity



# Ready Market?

Several International airlines with SAF ambitions already flying into South Africa








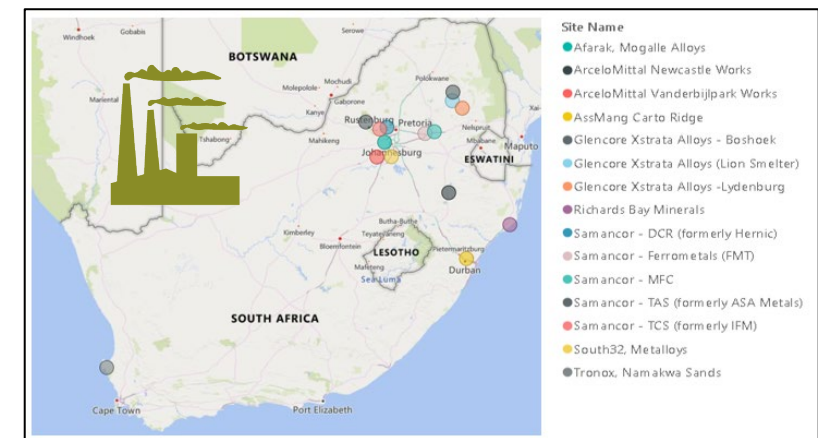
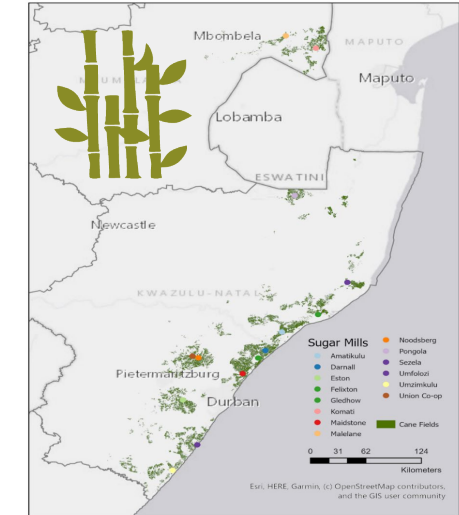
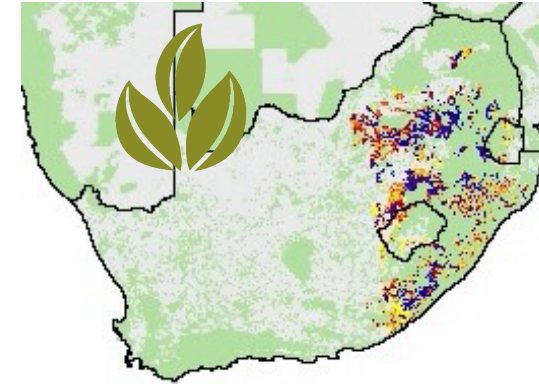
	Air France		Alitalia
	British Airways		Cathay Pacific
	Delta Airlines		Emirates
	Ethiopian Airways		Etihad
	KLM		LATAM Airlines
	Lufthansa		Qantas
	Qatar Airways		Singapore Airlines
	Swiss International Airlines		Turkish Airlines
	Virgin Atlantic Airways		United Airlines

N.B.: Pre-covid 19 pandemic

# Feedstock availability – South Africa



Feedstock	Potential availability
 Solaris	5,2 million tonnes of seed per annum
 A-molasses	165 000 tonnes per sugar mill per annum
 Industrial off-gas	3,34 million tonnes per annum
 Cleared IAPs	215 million oven-dry tonnes on less-than-35% slopes
 Garden waste	170 000 tonnes per annum at two municipal depots (Johannesburg and Eden)



# Approach to assessing SAF production potential



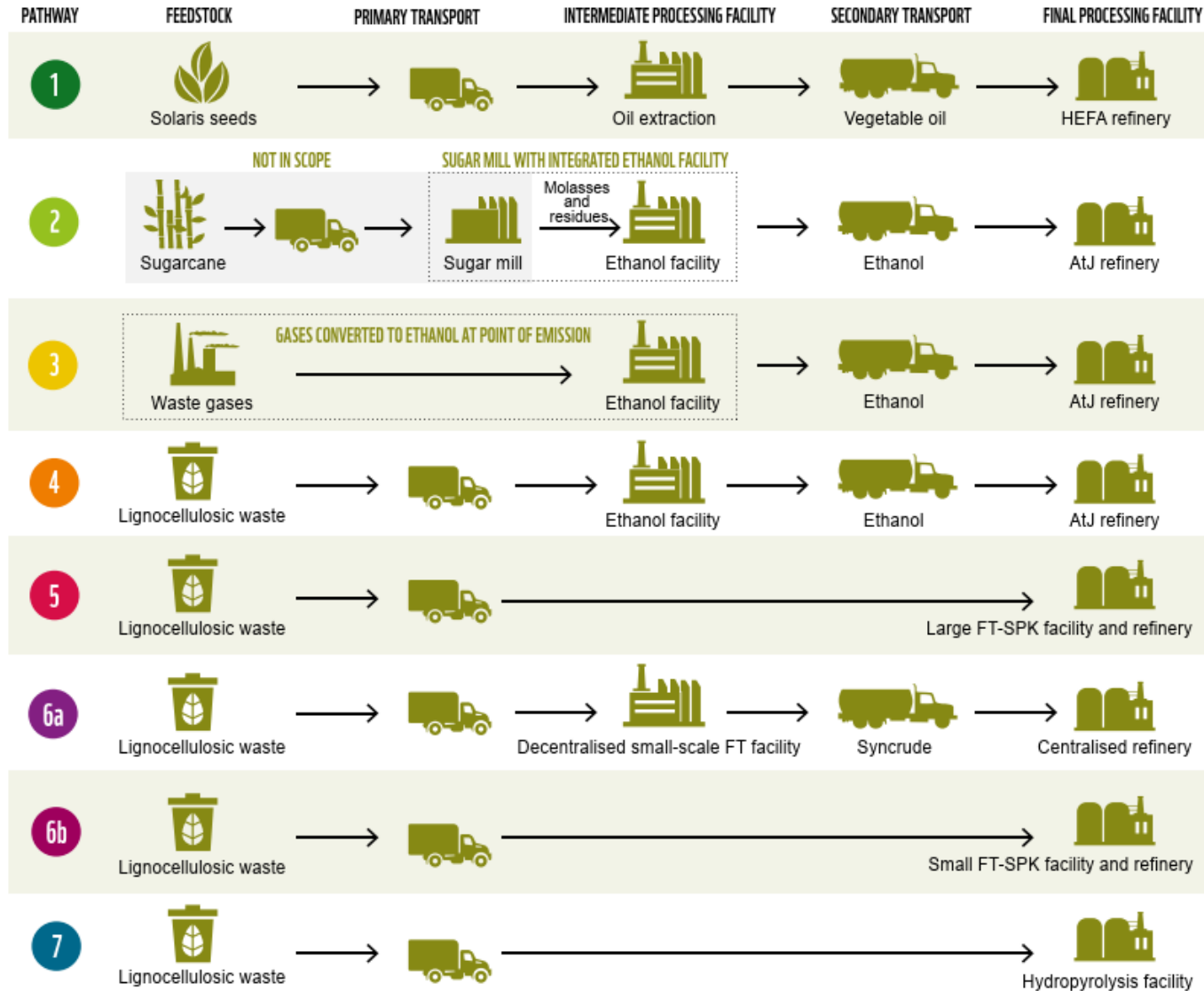
NETWORK  
OPTIMISATION  
Centre of gravity

2 scenarios:

- Energy self-sufficiency
- External (renewable) energy for green H2



TRANSPORT  
COSTING

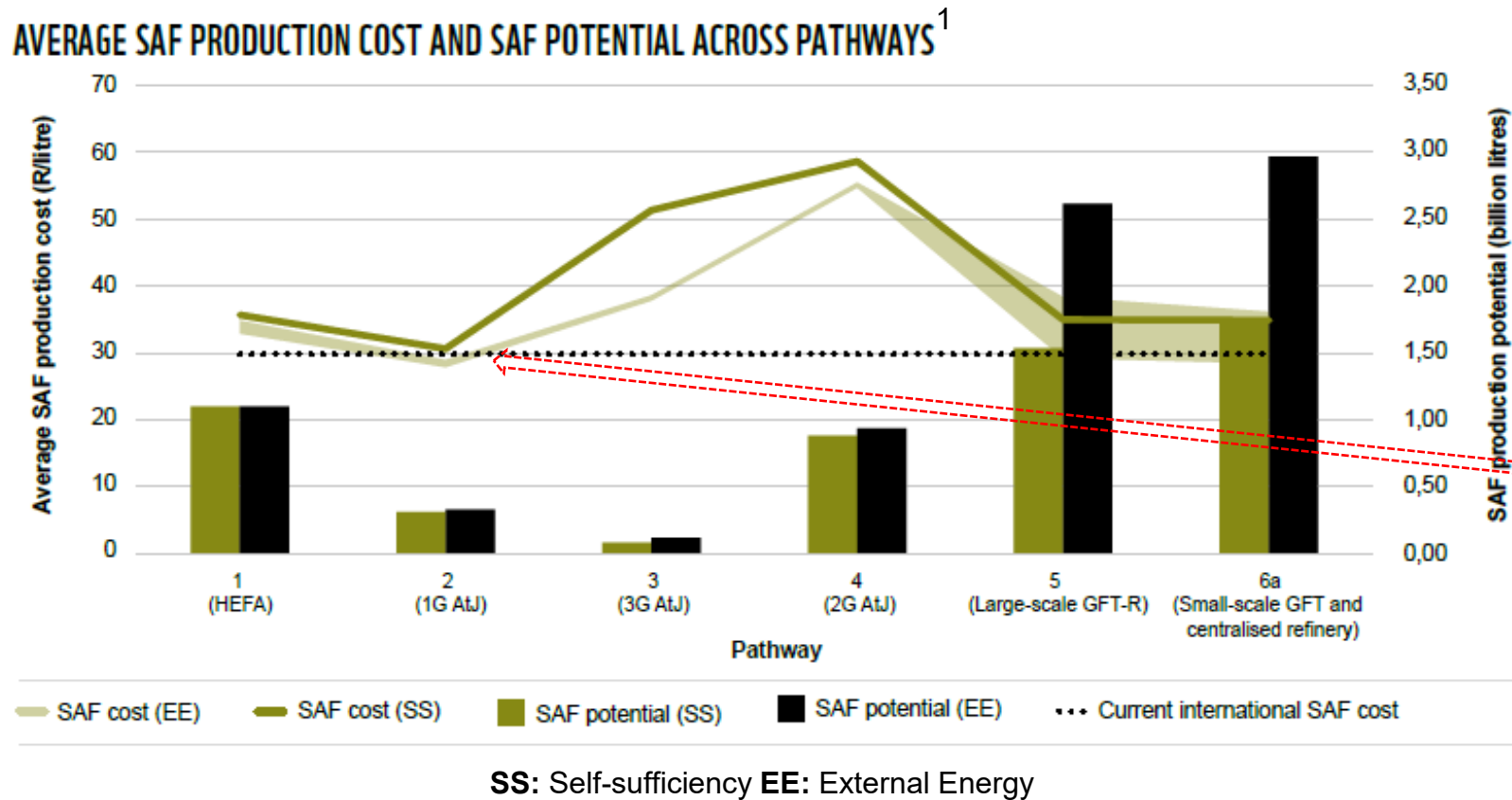


SAF  
PRODUCTION  
POTENTIAL &  
COST PER  
FACILITY



NATIONAL SAF  
PRODUCTION  
POTENTIAL

# SAF production costs – South Africa



Upper and lower parts of band in EE scenario represents green H2 costs of 4.4 and 2 \$/kg respectively.

Generally, external energy scenario more cost-effective than self-sufficiency scenario.

Pathway 2 cost-comparable with international SAF cost.

Cost-competitiveness of P5 and P6a in external energy scenario dependent on green H2 cost.

<sup>1</sup>P6b and 7 excluded as they were deemed least likely to be developed based on the results obtained in self-sufficiency scenario

# SAF production investments costs – South Africa

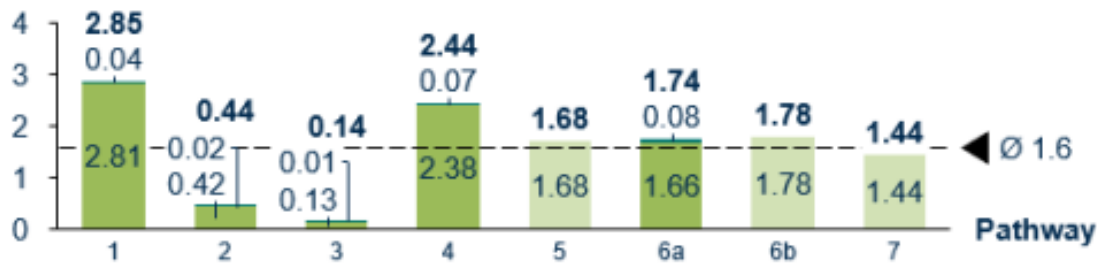


## Full pathway

Total investment Cost (Bil USD)



Total fixed & variable operating costs (Bil USD per annum)

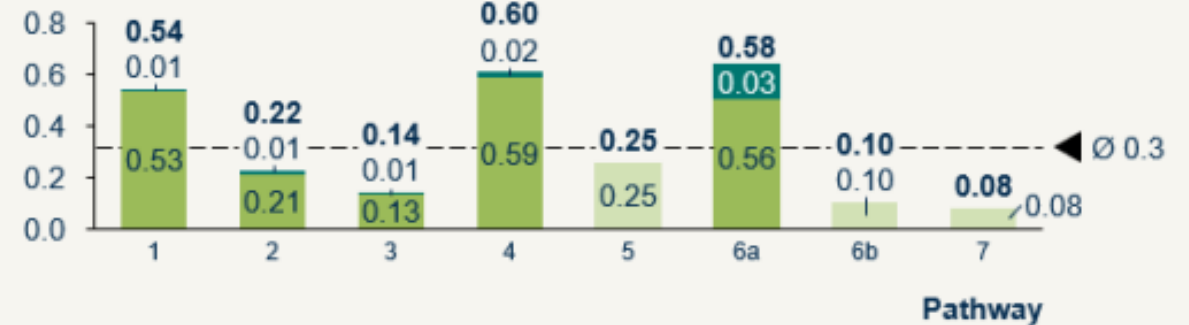


## Single installation (with related intermediate installation)

Total investment Cost (Bil USD)



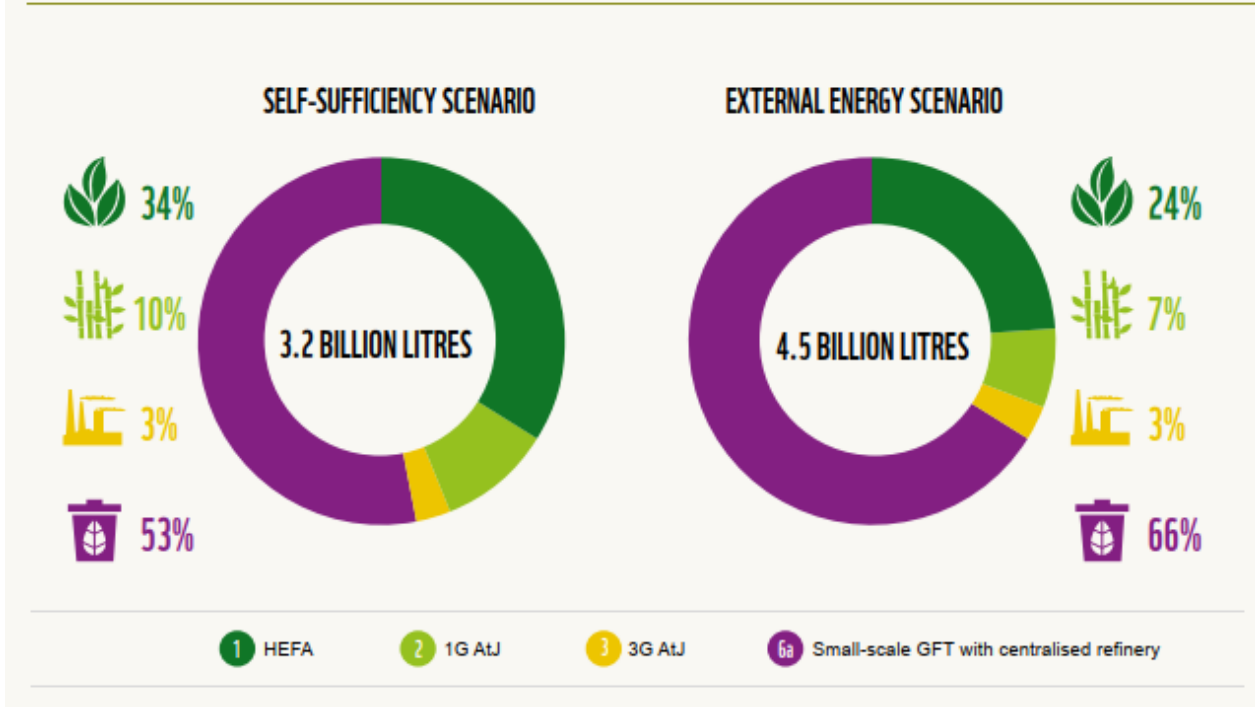
Total fixed & variable operating costs (Bil USD per annum)



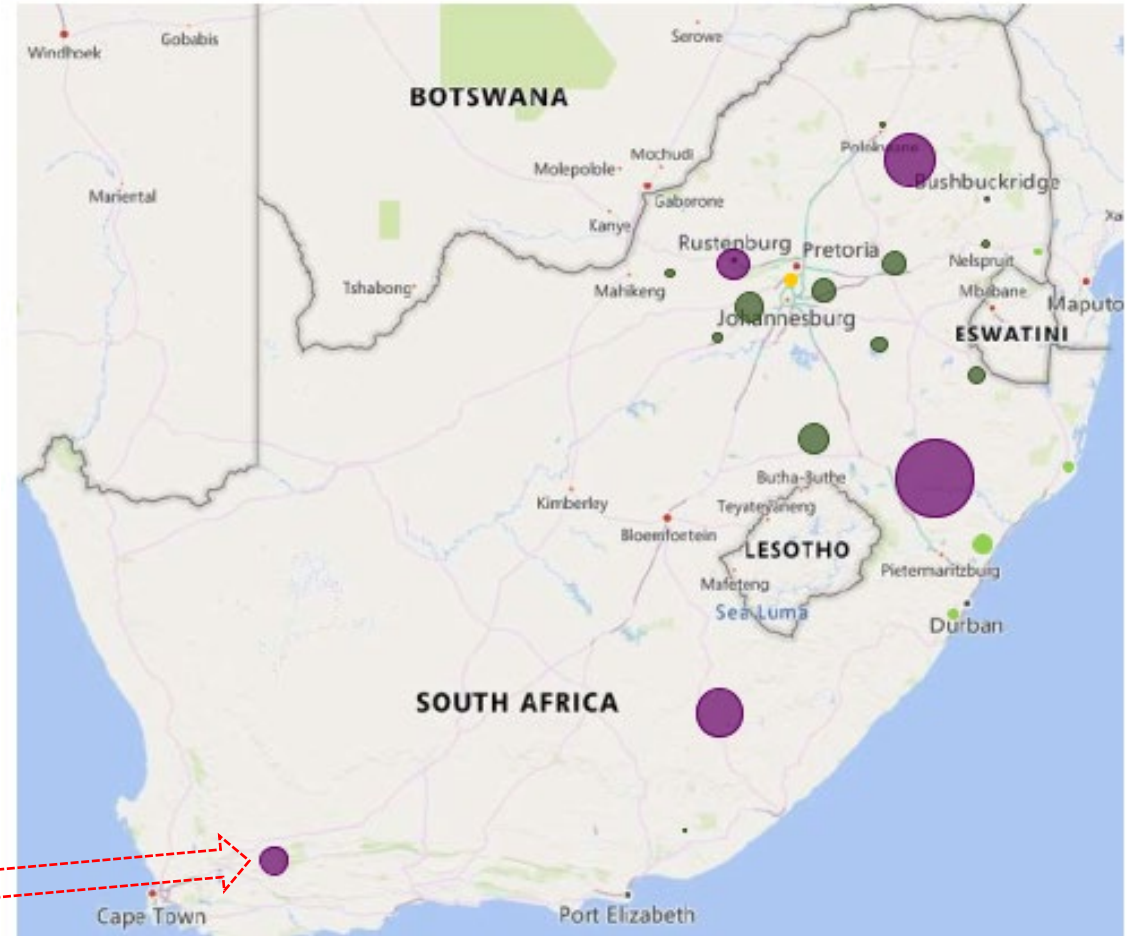
# South Africa's SAF production blueprint



## SAF PRODUCTION POTENTIAL IN SOUTH AFRICA



## LOCATIONS OF PROPOSED SAF FACILITIES IN SOUTH AFRICA



● P1 (HEFA) ● P2 (1G AtJ) ● P3 (3G AtJ) ● P6a (Small-scale GFT and centralised refinery)

- Montagu facility potential: 202–352 million litres p.a.
- About 30 – 52 % of CTIA annual demand

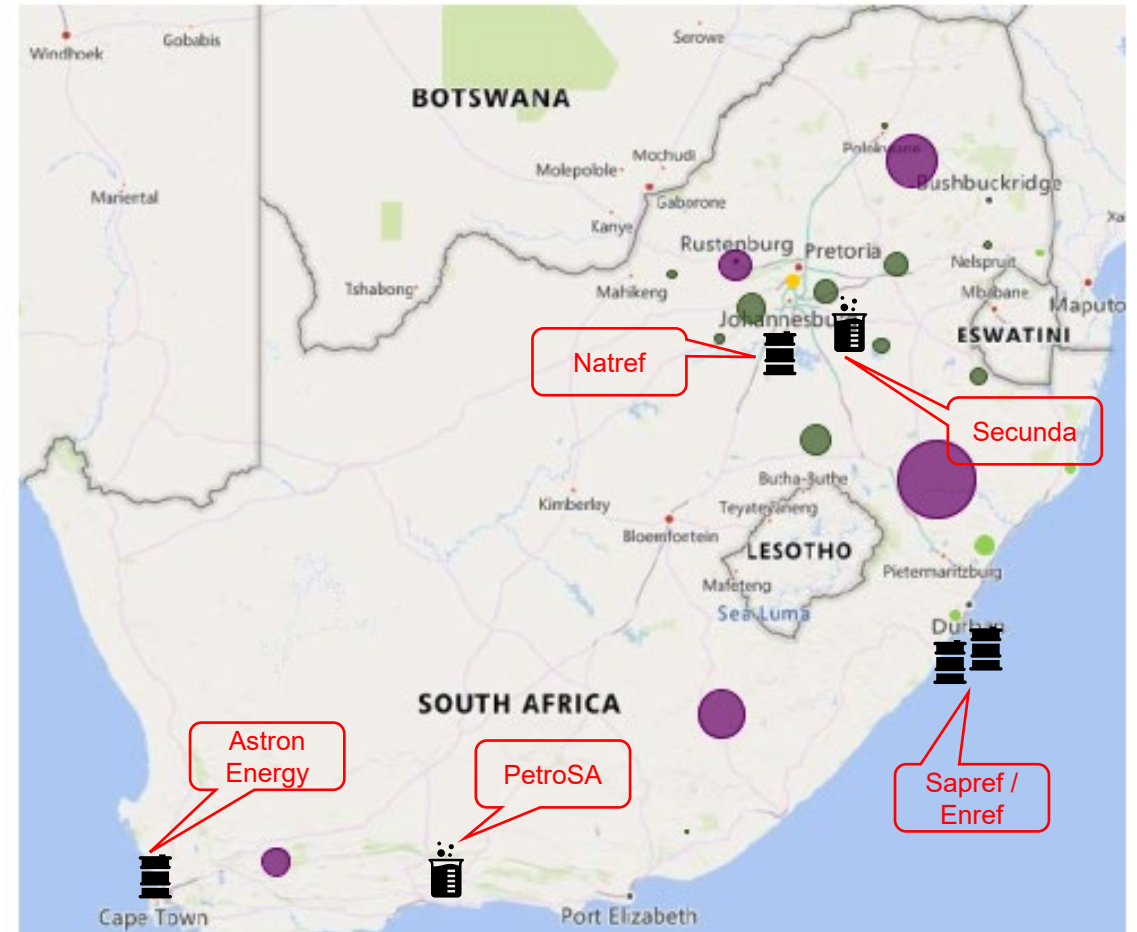
Annual jet fuel consumption in SA was **2.5 billion litres** pre-Covid-19 pandemic  
 SAF meets sustainability requirements of the Roundtable on Sustainable Biomaterials (RSB)

# Opportunity – making use of existing refineries



- Utilising brownfield facilities can reduce SAF production costs.
- **Secunda**: lignocellulosic biomass (invasive alien plants)
- **Natref**: lipid-based feedstocks
- **Sanref** and **Enref**: sugarcane-based ethanol
- **PetroSA**: lignocellulose-based ethanol/butanol

LOCATIONS OF PROPOSED SAF FACILITIES IN SOUTH AFRICA



● P1 (HEFA) ● P2 (1G AtJ) ● P3 (3G AtJ) ● P6a (Small-scale GFT and centralised refinery)  
■ Crude oil refinery ■ Synthetic refinery

# Biomass delivery to Sasol (Secunda) and PetroSA (Mossel Bay)



The cover of the report is teal with white and light blue text. It features the South African coat of arms, the Switch Africa Green logo, and the European Union flag. The title is 'WP1 Summary report: Optimising waste biomass supply for production of sustainable aviation fuel in South Africa'. Below the title is the 'wastetowings' logo, which consists of a white paper airplane icon above the text 'wastetowings'. The authors are listed as Tjaša Bole-Rentel (WWF-SA), Wim Hugo (SAEON), Arianna Baldo & Aurea Nardelli (RSB), Dr Abdul Petersen & Prof Johann Cörgens (SUN), and Berndt Burger & Shivani Sooklal (IMS). At the bottom, it says 'August 2019' and includes logos for FETOLA, WWF, and SkyNRG.

switchafrica GREEN

Funded by the European Union

WP1 Summary report:  
Optimising waste biomass supply for production of sustainable aviation fuel in South Africa

wastetowings

Prepared by:  
Tjaša Bole-Rentel (WWF-SA)  
Wim Hugo (SAEON)  
Arianna Baldo & Aurea Nardelli (RSB)  
Dr Abdul Petersen & Prof Johann Cörgens (SUN)  
Berndt Burger & Shivani Sooklal (IMS)

This report summarises the activities undertaken under WP1 of the Waste to wing project funded by the EU programme Switch Africa Green (contract number DCI-ENV/2017/591-384)  
Please direct any questions or comments to WP1 lead Tjaša Bole-Rentel at [tjasa@wwf.org.za](mailto:tjasa@wwf.org.za)

August 2019

FETOLA WWF SkyNRG

The title page is white with black text. It features the South African coat of arms, the UNIDO logo, and the GEF logo. The project title is 'Technical and economic pre-feasibility of biomass waste utilization for production of sustainable aviation fuel by PetroSA'. Below the title is the contract number '3000082110/UNIDO Project SAP ID 130310'. The main title is 'Full pre-feasibility of ethanol supply for production of sustainable aviation fuel'. The compilers are Tjaša Bole-Rentel & Farai Chireshe (WWF-SA). The researchers are Dr William Stafford, Greg Forsyth, David Le Maitre and Ryan Blanchard (CSIR), Professor Johann Cörgens, Dr Oseweuba Valentine Okoro and Dr Abdul Petersen (SU), and Avania Ravinath, Geoffrey Ellis and Lerato Mnyakeni (Imperial Logistics). The date is February 2021. At the bottom, it includes logos for WWF, CSIR, University of Stellenbosch, and Imperial University.

Project Title : "Technical and economic pre-feasibility of biomass waste utilization for production of sustainable aviation fuel by PetroSA"  
(Contract Number 3000082110/UNIDO Project SAP ID 130310)

Full pre-feasibility of ethanol supply for production of sustainable aviation fuel

Compiled by:  
Tjaša Bole-Rentel & Farai Chireshe (WWF-SA)

Based on the research by:  
Dr William Stafford, Greg Forsyth, David Le Maitre and Ryan Blanchard (CSIR)  
Professor Johann Cörgens, Dr Oseweuba Valentine Okoro and Dr Abdul Petersen (SU)  
Avania Ravinath, Geoffrey Ellis and Lerato Mnyakeni (Imperial Logistics)

February 2021

WWF CSIR UNIVERSITEIT STELLENBOSCH UNIVERSITY 100 Imperial beyond possibility

A photograph of an airplane wing in flight against a sunset sky with clouds. The wing is white and extends from the bottom left towards the top right. The sky is a mix of blue and orange, with large, fluffy white clouds. The sun is visible as a bright, glowing orb on the right side of the frame, creating a lens flare effect. The overall mood is serene and expansive.

## **SOCIO-ECONOMIC & MACRO-ECONOMIC IMPACTS**

# Socio-economic impacts of a domestic SAF industry



IF AS MUCH AS POSSIBLE OF THE CONSTRUCTION MATERIALS AND EQUIPMENT IS MANUFACTURED IN SOUTH AFRICA, THE CONSTRUCTION PHASE ALONE COULD CREATE ALMOST 40 000 DIRECT JOBS



GROWING SOLARIS IS LABOUR INTENSIVE AND COULD RESULT IN THE CREATION OF OVER 19 700 PERMANENT AGRICULTURE JOBS



**A DOMESTIC SAF SECTOR HAS THE POTENTIAL TO CREATE 90 000+ GREEN JOBS\* IN SOUTH AFRICA**

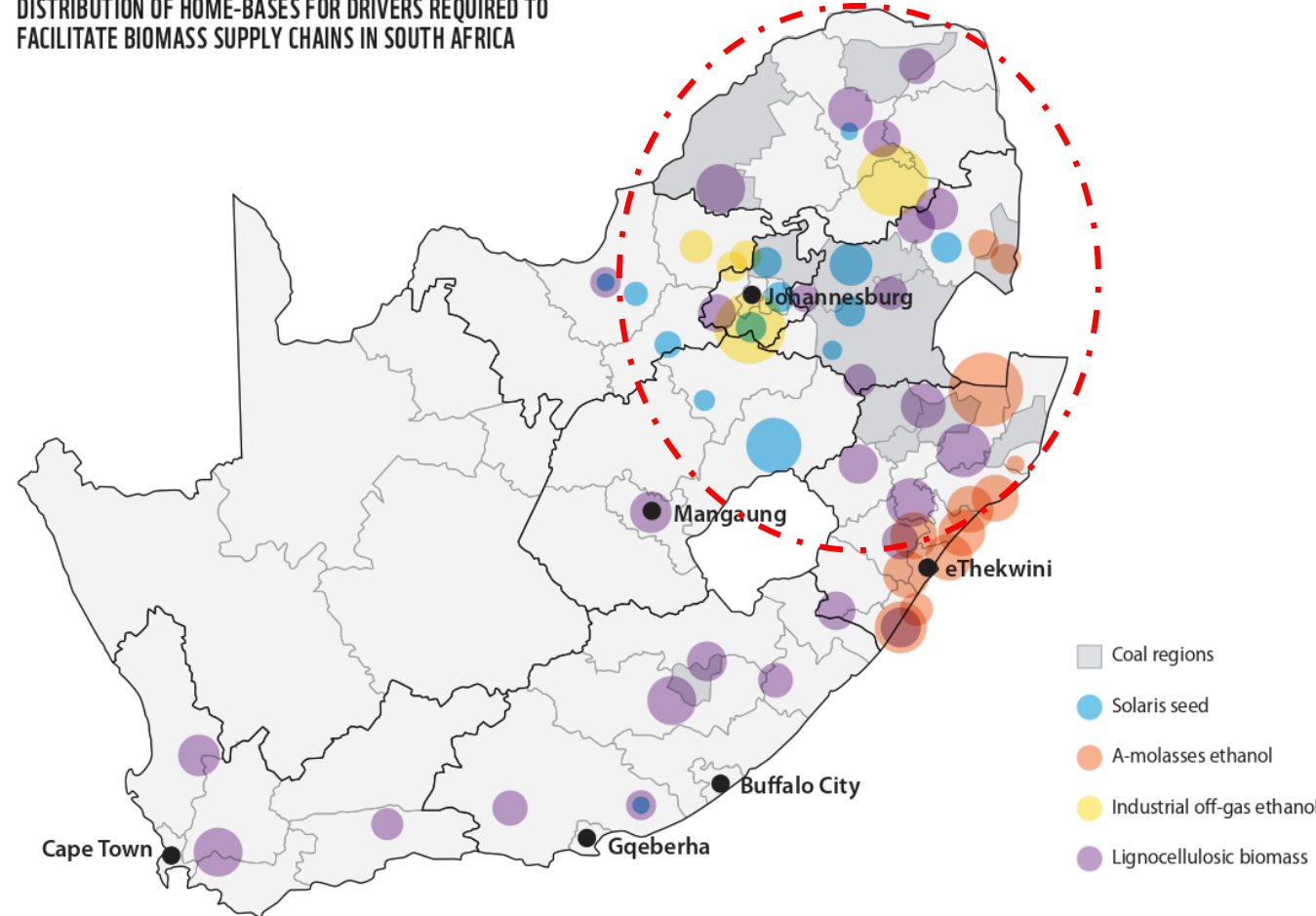
\*Direct Jobs

# Transport employment opportunities of a domestic SAF industry

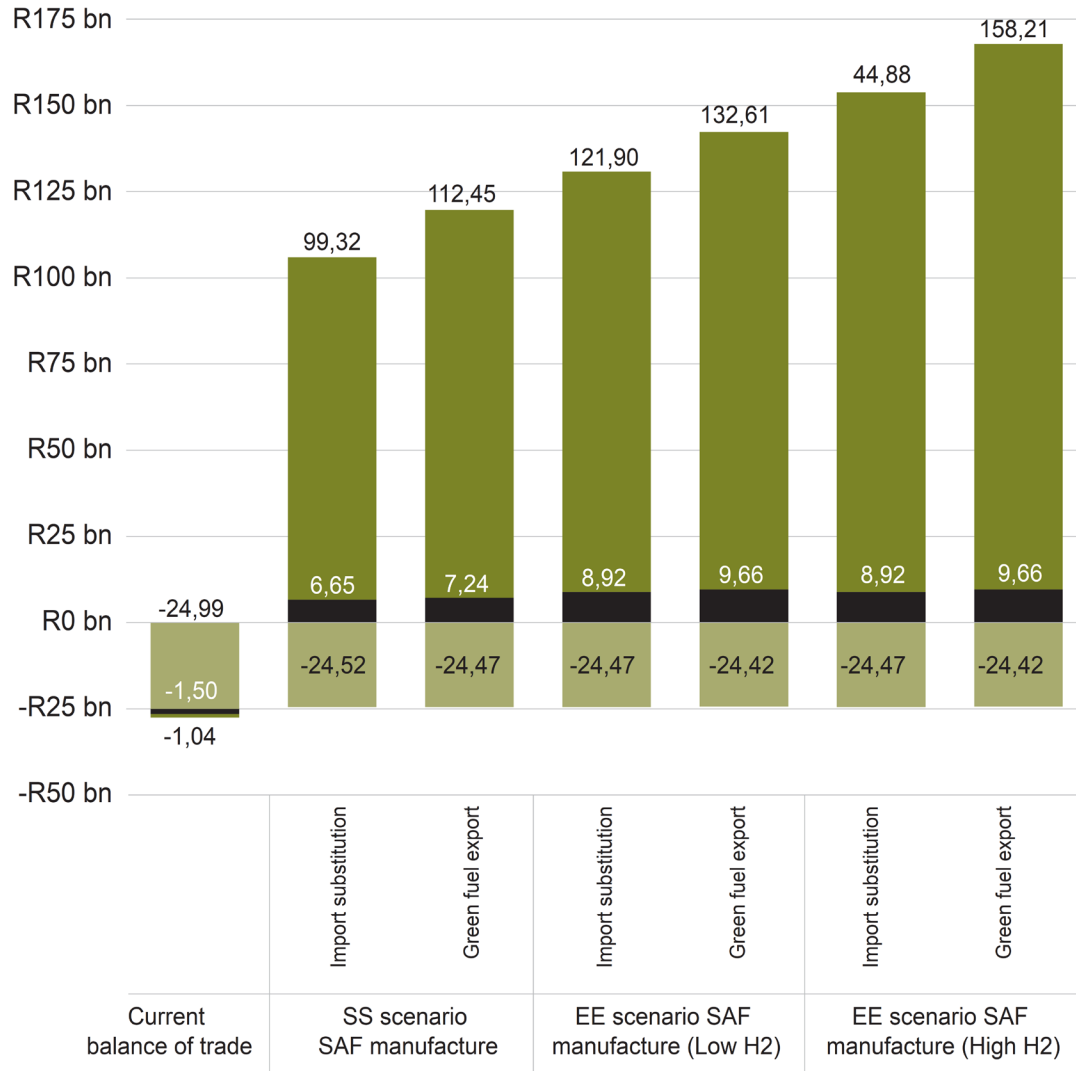


Almost 75% of the current coal hauling jobs (~ **3500 jobs**) could be directly transitioned to biomass transport because of overlap in coal and biomass supply chains and usage of the same truck types.

DISTRIBUTION OF HOME-BASES FOR DRIVERS REQUIRED TO FACILITATE BIOMASS SUPPLY CHAINS IN SOUTH AFRICA



# Macro-economic impacts of a domestic SAF industry

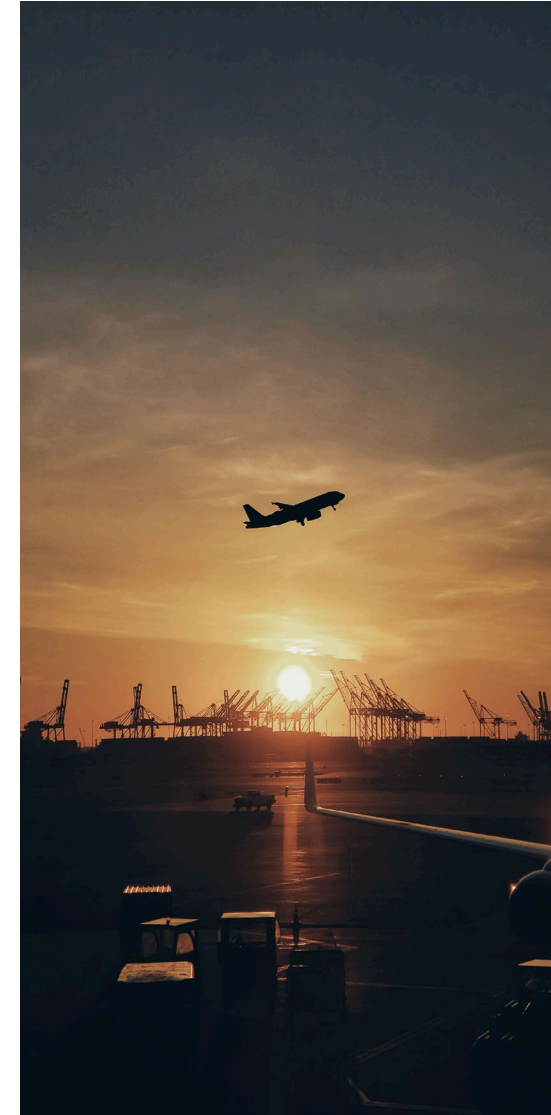


SAF implementation can improve South Africa's balance of trade by R81,5 billion to R170 billion per annum (5.4 – 11.4 billion USD).

# Key messages



- A domestic SAF industry could be a pillar of South Africa's low-carbon economy, playing a key role in the just transition process by creating over **90 000** green jobs.
- Feedstock production could provide employment to **7 500** truck drivers, **20 000** farm workers and possibly even bigger numbers of IAP harvesters and preserve at-risk jobs in sugarcane production.
- SAF industry can catalyse growth of South Africa's **green hydrogen economy**.
- Immediate technical potential: **3,2 – 4,5 billion** litres of SAF annually.
  - Export potential: **2–3,3 billion litres**.
- SAF export can improve SA's trade balance by **5.4 – 11.4 billion USD** per annum.
- Some of the assessed pathways already cost competitive with international SAF prices; several more could become competitive with relatively minor **policy support**.



# Next steps: A roadmap?



## Providing certainty for all players

Suppliers: Easier to secure feedstock supply chains with a firm trajectory for offtake.

Developers: SAF refinery development feasible if feedstock supply is certain and market demand locked in.

Government: Time to stabilise regulatory requirements; guidance for necessary support measures.

Financiers: Long term market demand lock-in means potential to assess returns.

**Staging** is critical to enable growth

# SA SAF Roadmap inception workshop: 14 June 2023



## Attendees

- Academia
- Aircraft manufacturers
- Airlines
- Airports
- Feedstock producers
- Fuel producers
- Financiers
- Government (National & Provincial)
- Organised Labour
- NGOs
- Research institutions



# Next steps: Demonstrate supply chains ?



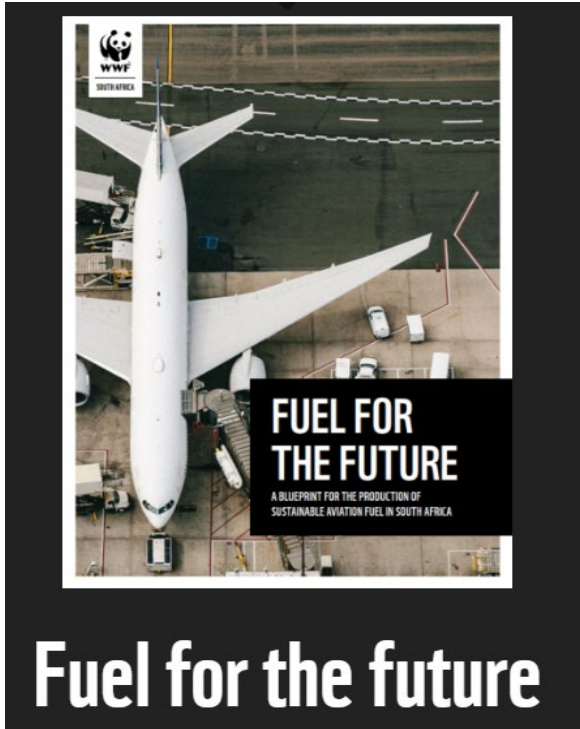
**Providing inputs into policy making process**

**Understand** supply chain dynamics for better policy decisions.

**Identify** gaps and inefficiencies to enable the development of policies that address specific challenges, promote efficiency.

**Evaluate** environmental, social and sustainability risks to formulate policies that promotes sustainable development.

**Assess** impact of supply chain to anticipate unintended consequences and identify potential risks or challenges associated with policy implementation.



# THANK YOU FOR YOUR ATTENTION



For more information on SAF visit: [https://www.wwf.org.za/our\\_work/initiatives/sustainable\\_aviation\\_fuel/](https://www.wwf.org.za/our_work/initiatives/sustainable_aviation_fuel/)



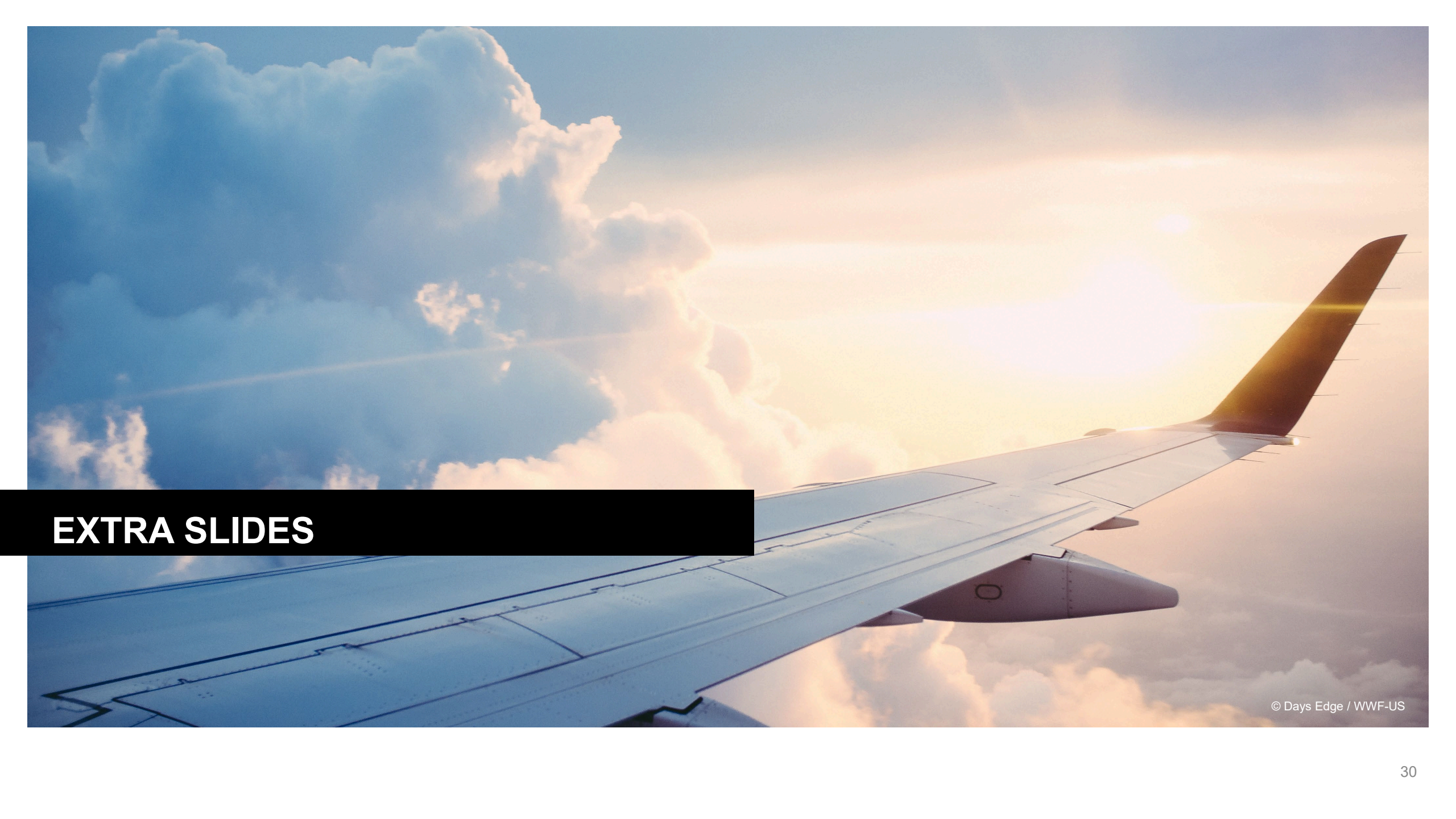
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1<sup>st</sup> Floor, Bridge House, Boundary Terraces Mariendahl Lane, Newlands, Cape Town. P.O.Box 23273, Claremont 7735, t +27 21 657 6600, e: [info@wwf.org.za](mailto:info@wwf.org.za), [fchireshe@wwf.org.za](mailto:fchireshe@wwf.org.za), [www.wwf.org.za](http://www.wwf.org.za)



**EXTRA SLIDES**

# Invasive Alien Plants (IAPs): Ideal Feedstock for South Africa

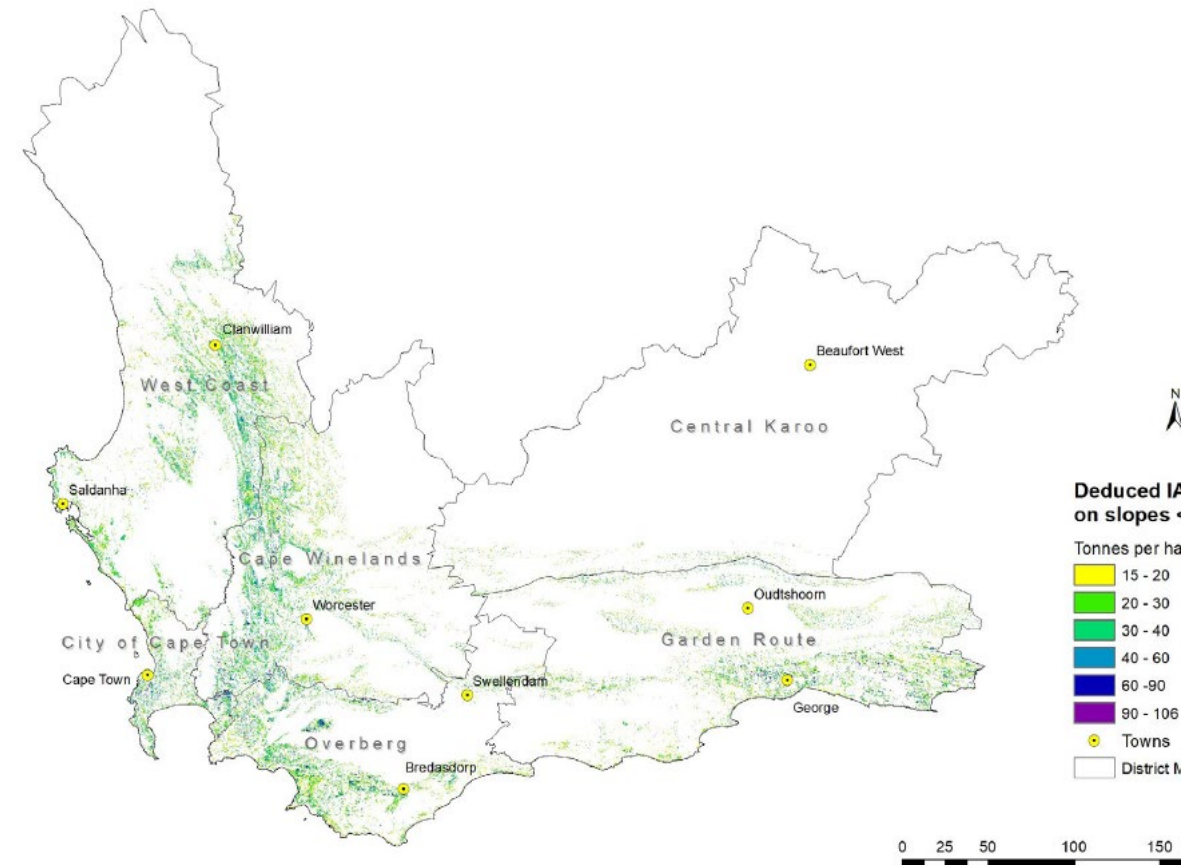


IAPs are a threat to:

- Biodiversity
- Water security
- Productive use of land
- Ecological function of ecosystems

IAP removal is mandated by law

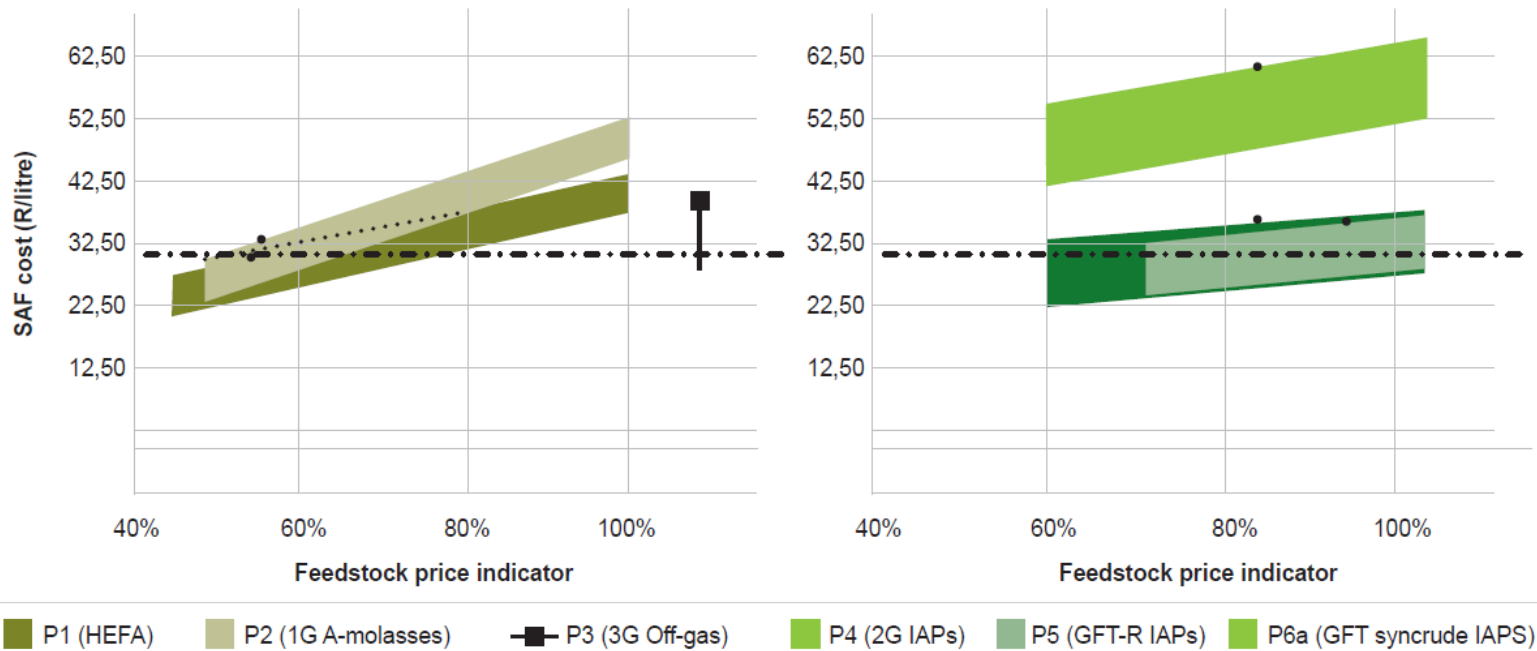
## IAP availability in Western Cape



# Sensitivity analysis



EFFECTS OF FEEDSTOCK COST AND WEIGHTED AVERAGE COST OF CAPITAL ON FINAL SAF COST



Breadth of the band shows lower and upper WACC considered (10% and 20%)

Slope of band shows effect of normalised feedstock prices

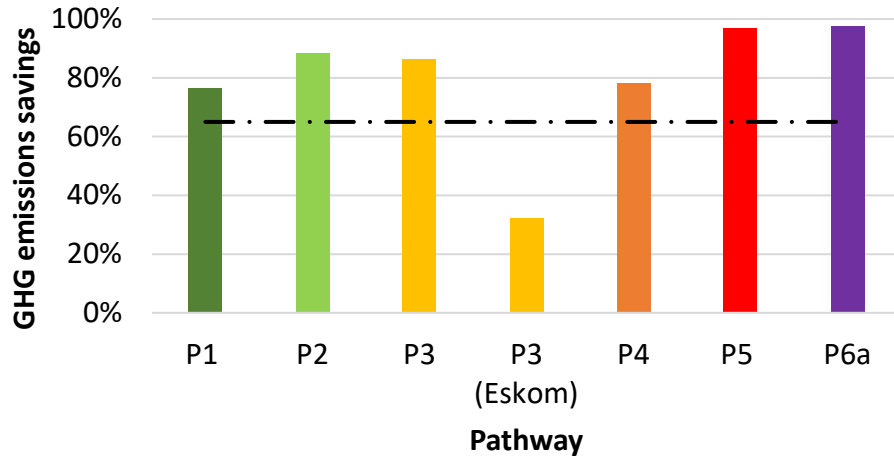
Marked points show reference values considered in pathway analysis

Effect of feedstock price variation most significant for P1 & P2

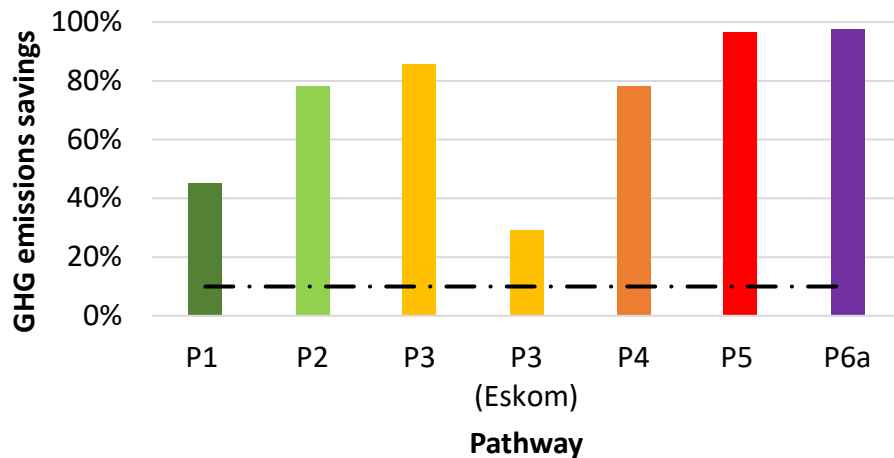
Effect of WACC most prominent for P3, P4, P5 & P6a

Premiums for green co-products can also be considered to lower SAF costs

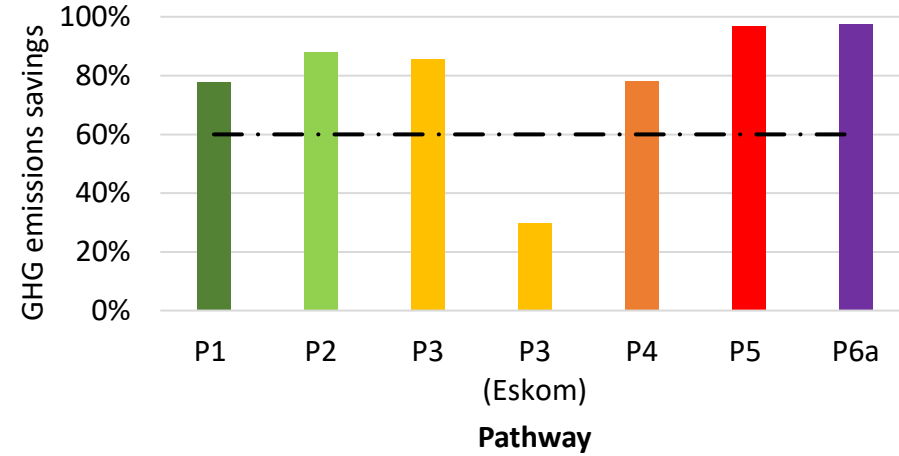
# GHG analysis - LCA



--- EU RED II threshold



--- CORSIA threshold



--- RSB Global threshold

Most pathways achieved at least a 70% emissions reduction compared to conventional fossil-based jet-fuel

P1 (HEFA) achieves a 45% GHG saving if land use change is considered (CORSIA)

P3 (3G AtJ) achieves a 29% GHG saving when Eskom (grid electricity) is used