

# Rethinking Biorefineries for New Zealand:

Anything made from oil today can be made from a tree tomorrow

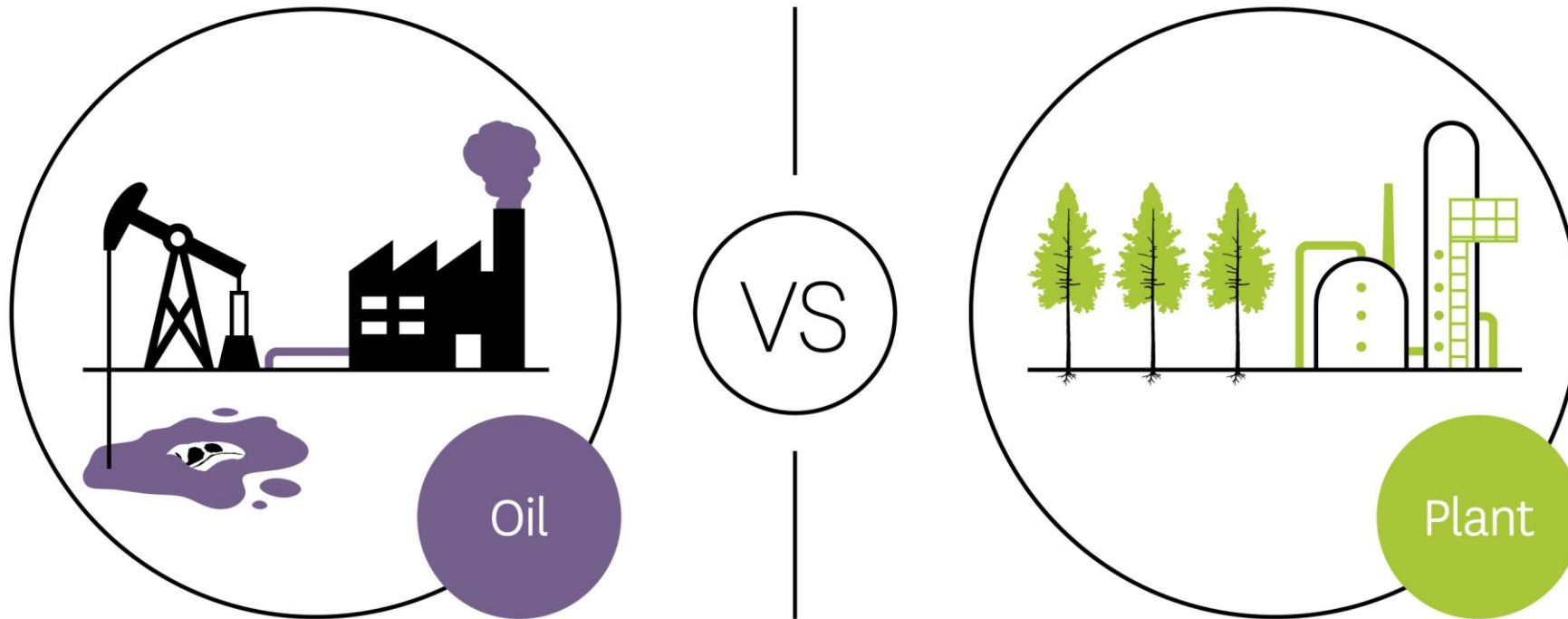


Marie Joo Le Guen

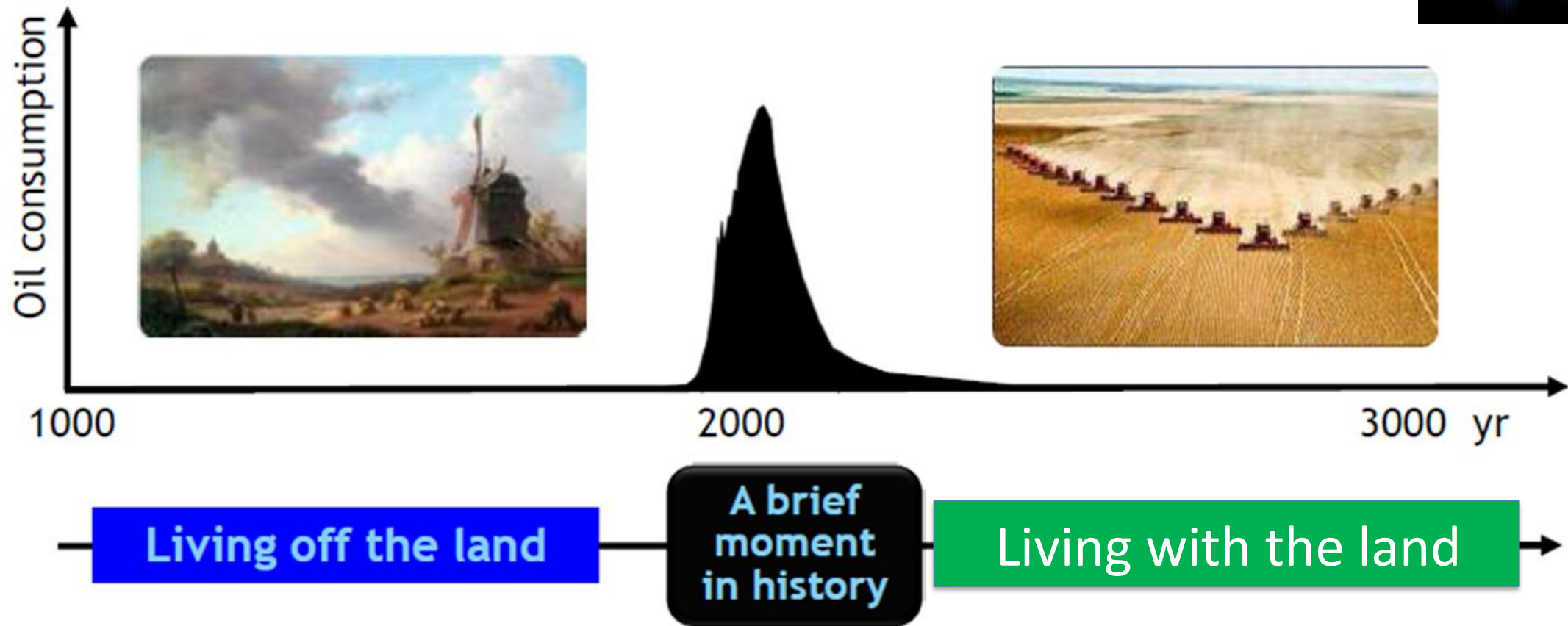
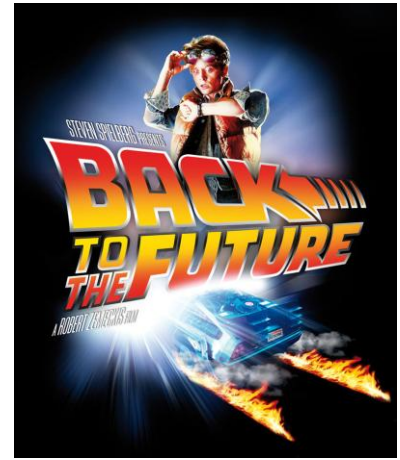
12th Asia International Conference On Leather Science And Technology  
18 October 2022 in Palmerston North, New Zealand

# Oil-based vs Tree-based feedstock for refining

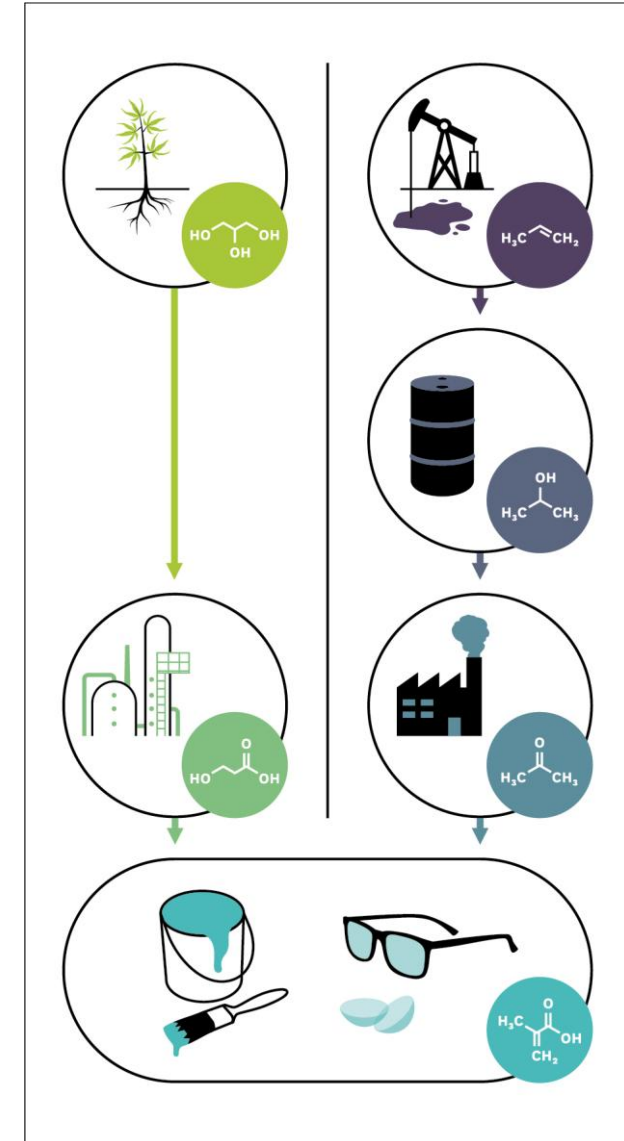
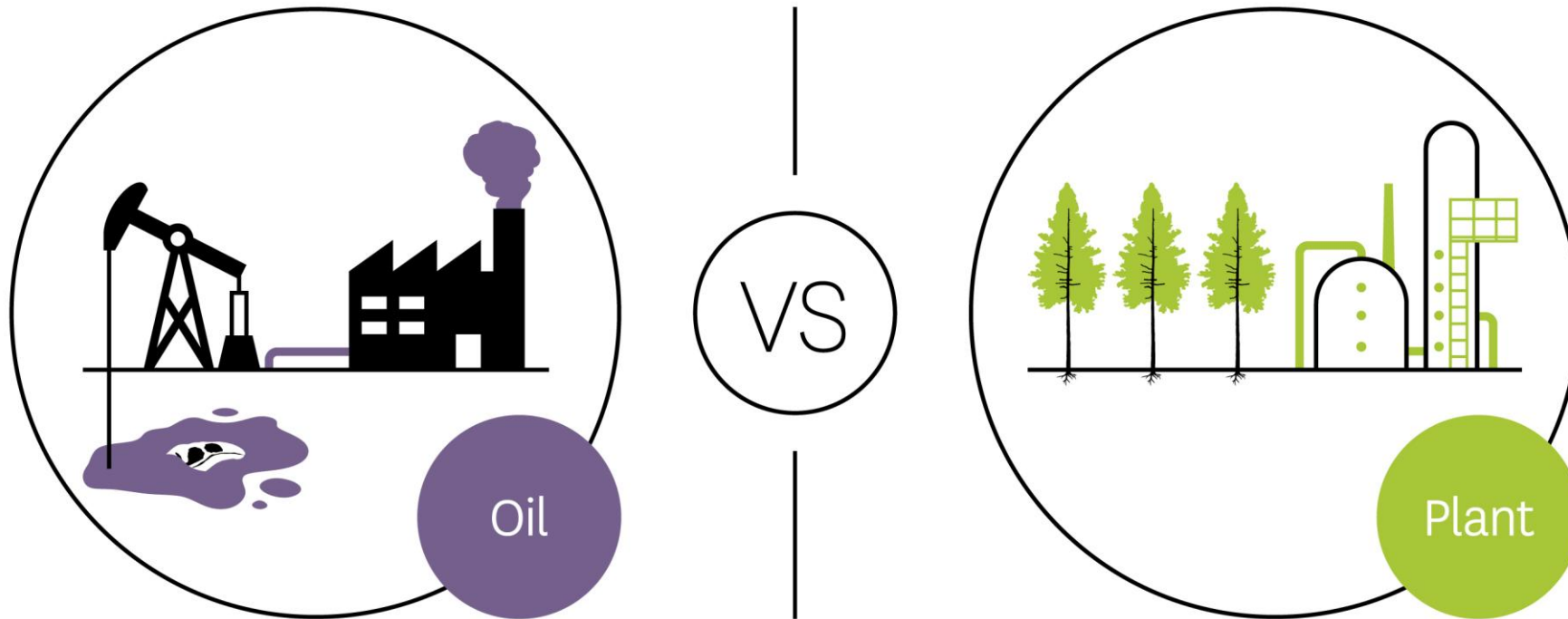
Using unsustainable resources from underground or sustainable resources from above ground



# Back to the Future: An oil-based economy is not sustainable in the long term



# Biorefineries can produce identical products





# But we have enough oil

The Stone Age  
did not end for a  
lack of stones....



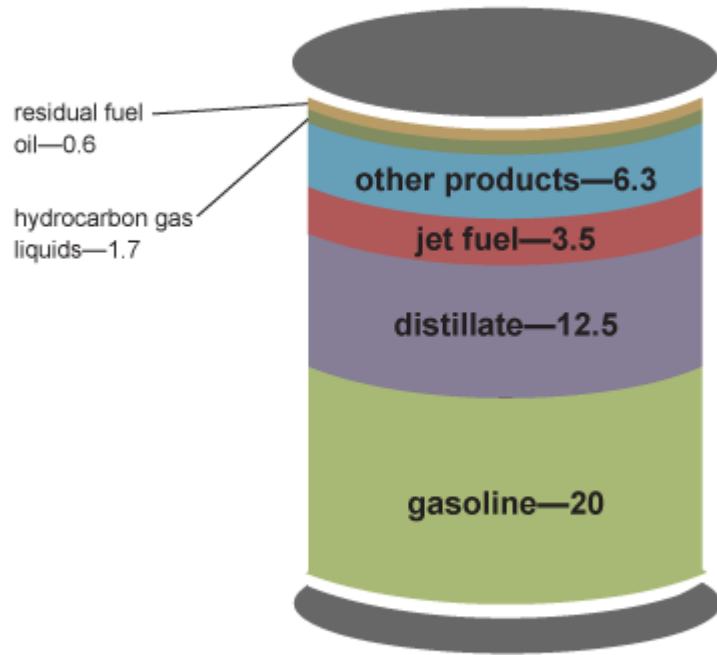
...and the Oil  
Age will end  
long before the  
world runs out  
of oil



$$C^{\text{fossil}} = C^{\text{energy}} + C^{\text{chemicals}}$$

### Petroleum products made from a barrel of crude oil, 2021

gallons



Source: U.S. Energy Information Administration, *Petroleum Supply Monthly*, March 2022, preliminary data

Note: A 42-gallon (U.S.) barrel of crude oil yields about 45 gallons of petroleum products because of refinery processing gain. The sum of the product amounts in the image may not equal 45 because of independent rounding.

Adhesives and sealants  
Agrochemicals  
Construction chemicals  
Corrosion control chemicals  
Cosmetics raw materials  
Electronic chemicals and materials  
Flavourings, fragrances, food additives  
Pharmaceutical drugs  
Specialty and industrial chemicals  
Specialty and industrial gases  
Inks, dyes and printing supplies  
Packaging, bottles, and containers  
Paint, coatings, and resins  
Polymer additives  
Specialty and life sciences chemicals  
Surfactants and cleaning agents



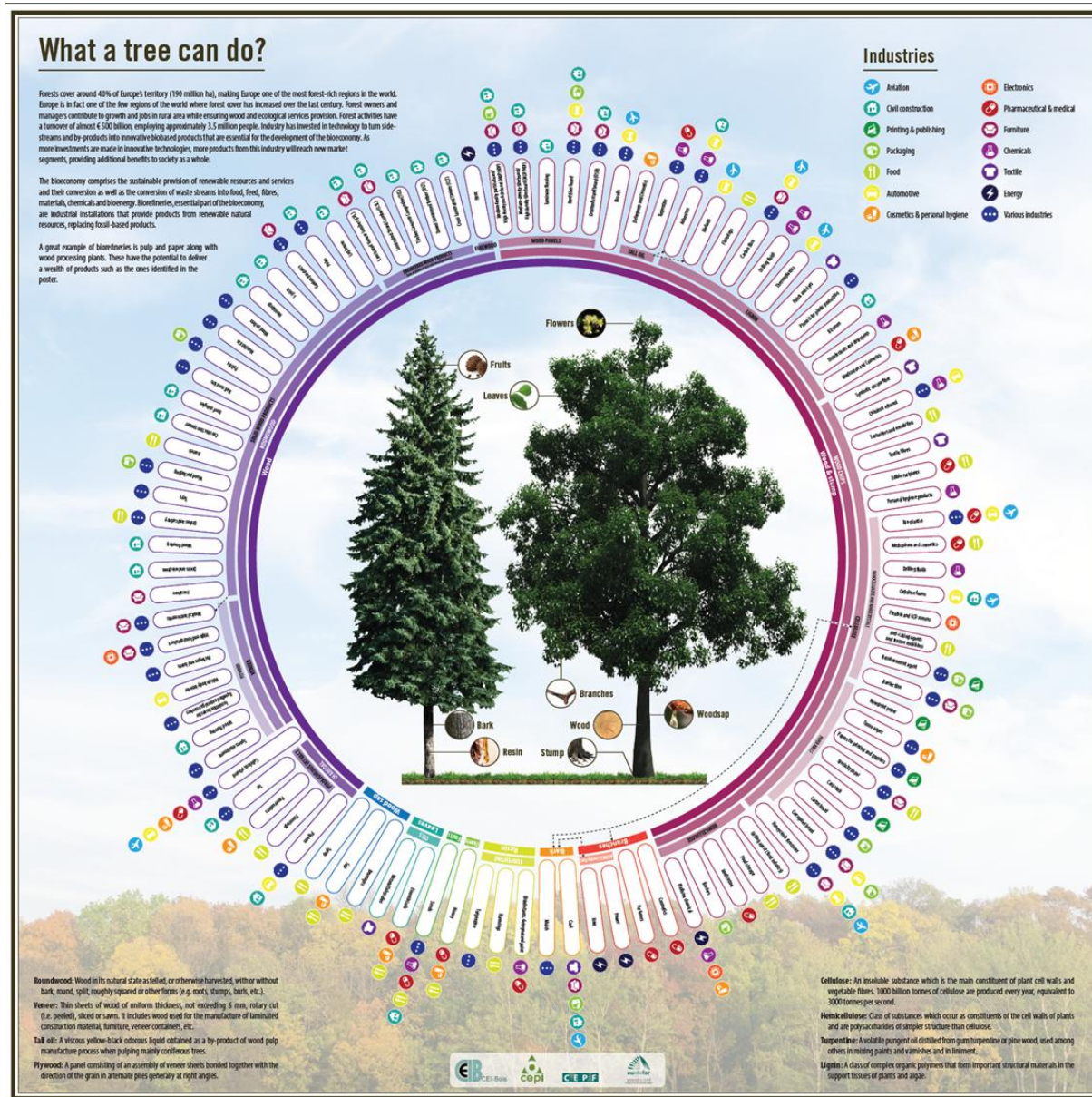
$$C_{\text{sustainable}} = C_{\text{bioenergy}} + C_{\text{biochemicals}}$$



Adhesives and sealants  
Agrochemicals  
Construction chemicals  
Corrosion control chemicals  
Cosmetics raw materials  
Electronic chemicals and materials  
Flavourings, fragrances, food additives  
Pharmaceutical drugs  
Specialty and industrial chemicals  
Specialty and industrial gases  
Inks, dyes and printing supplies  
Packaging, bottles, and containers  
Paint, coatings, and resins  
Polymer additives  
Specialty and life sciences chemicals  
Surfactants and cleaning agents



# Trees can have a massive impact beyond wood & pulp



## Industries

- Aviation
- Civil construction
- Printing & publishing
- Packaging
- Food
- Automotive
- Cosmetics & personal hygiene
- Electronics
- Pharmaceutical & medical
- Furniture
- Chemicals
- Textile
- Energy
- Various industries



Scion strategy to 2030

# RIGHT TREE, RIGHT PLACE, RIGHT PURPOSE

## Our Mission

Enhancing New Zealand's prosperity, well-being and environment through trees.

*Kia piki te ora, te taiao me te whai rawa o Aotearoa mā te ngāherehere.*

# Making impact three ways

To reach our 2050 aspirations, we defined three research impact areas to 2030.



Forests and landscapes



Forests to timber products



Forests to biobased products



# Research Group Leaders & Portfolio Leaders

## Te Ao Maori and Science Services

Hemi Rolleston

## Chemistry and Physics

Kirk Torr (LWOP) Kim McGrouther (Acting)

## Data and Geospatial Intelligence

Marie Joo Le Guen (Acting)

## Ecology and Environment

Stuart Fraser

## Economy and Society

Grace Villamor

## Forest Genetics & Biotechnology

Gareth Lloyd-Jones

## Materials, Engineering & Manufacturing

Marie Joo Le Guen

## Plant Development & Physiology

Vacant (Kelly Turner - Team Lead)

## Te Ao Māori

Shontelle Bishara

## IA1 Forest and Landscapes

Tara Strand

### Establishing Indigenous Forests

IA1.01 – H14039

Heidi Dungey

### Restoration, Protection & Mauri o Te Waonui a Tāne

IA1.02 – H14139

Katerina Pihera-Ridge

### Designing Forests - Mahi Tahī Whāihua

IA1.03 – H14239

Steve A Wakelin

## IA2 Forests to Timber Products

Vacant (Doug Gaunt Acting)

### Trees for High Volume Wood Products

IA2.01 – H14339

Andrew Cridge

### Trees for High Value Wood Products

IA2.02 – H14439

Andrea Stocchero

### Indigenous Trees for Distinct Value Wood Products

IA2.03 – H14539

Liz Dunningham (Acting)

### New Value from a Digital Forest and Wood Sector

IA2.04 – H14639

Claire Stewart

## IA3 Forests to Biobased Products

Florian Graichen

### High Value Biorefineries

IA3.01 – H14739

Stefan Hill

### Bioproducts and Packaging

IA3.03 – H14939

Alec Foster

### Distributed and Circular Manufacturing

IA3.03 – H14939

Marc Gaugler

### Integrated Bioenergy

IA3.04 – H15039

Paul Bennett

# High-value chemicals



Cosmeceuticals



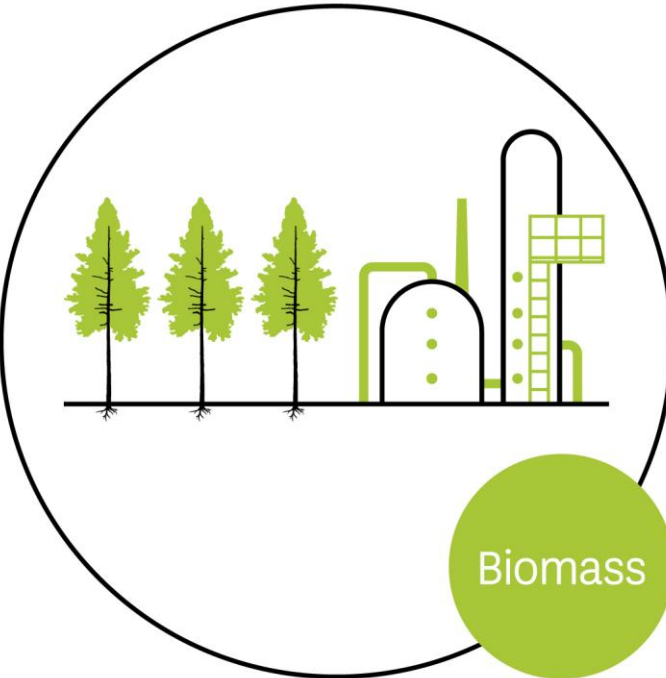
Nutraceuticals



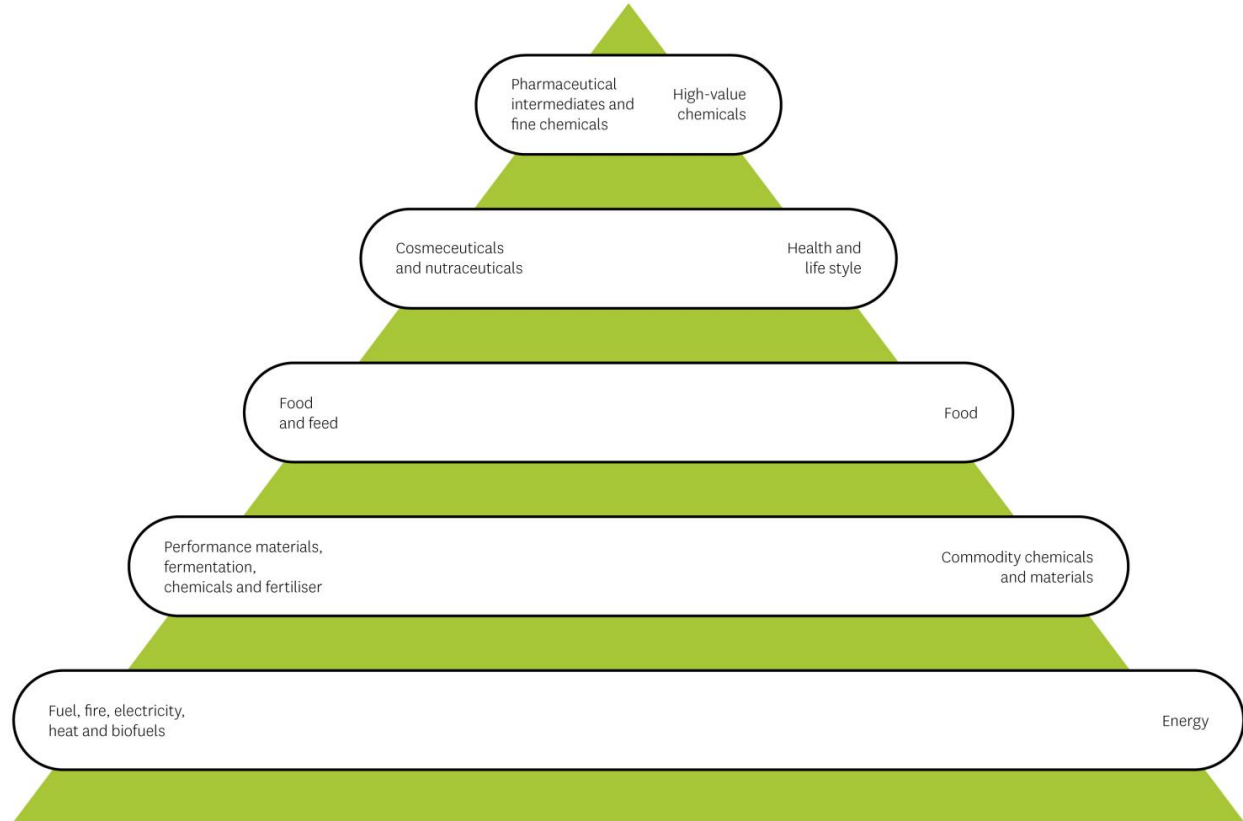
Fine  
Chemicals



Pharmaceutical  
Intermediates



Value ↑



Volume ↓



# New Zealand case study – A Bark Biorefinery

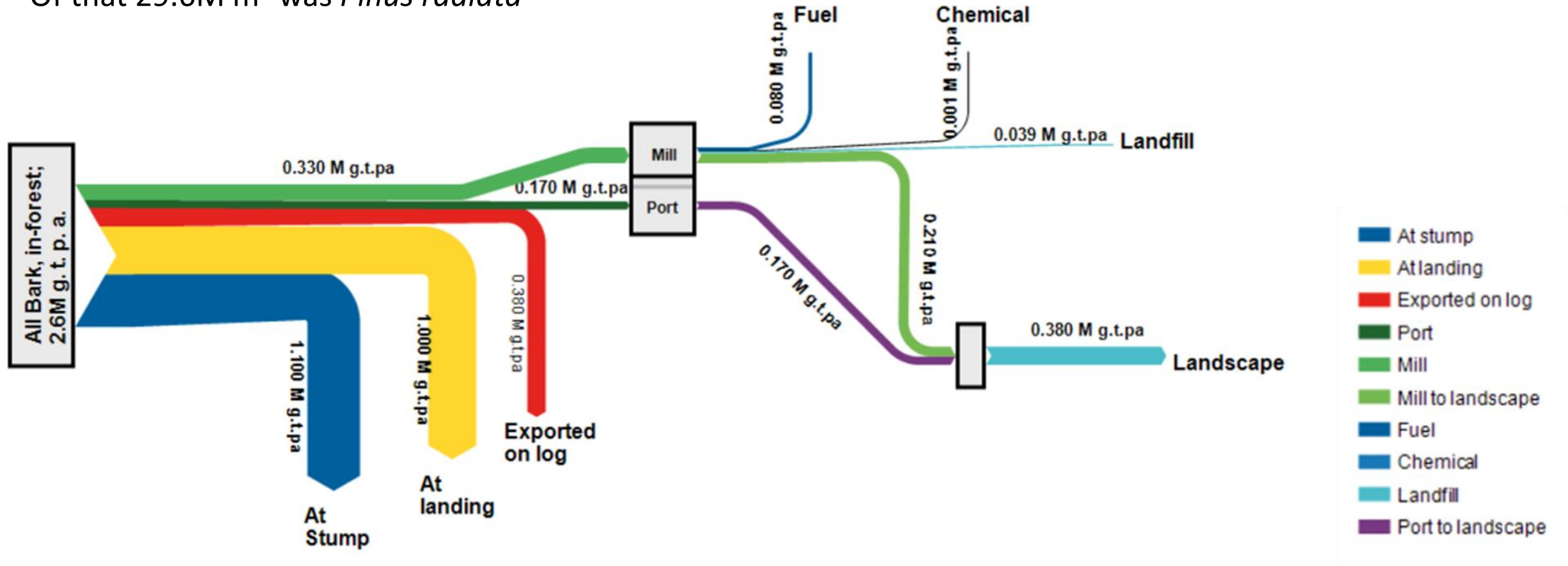
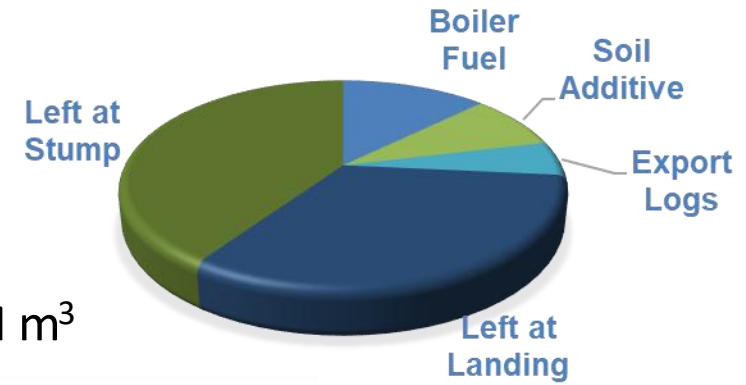
- 5-year Scion led MBIE funded Programme (2018 – 2023)
- Focus on delivering a Pine Bark based Biorefinery
  - A range of products from commodity to high-value
  - Zero waste by converting solid residue into bark briquettes
- Partnering with forestry, bark suppliers, large scale extraction capability, end-users, and National and International research providers (Germany, Portugal, Finland).



## Bark Biorefinery - mass flow

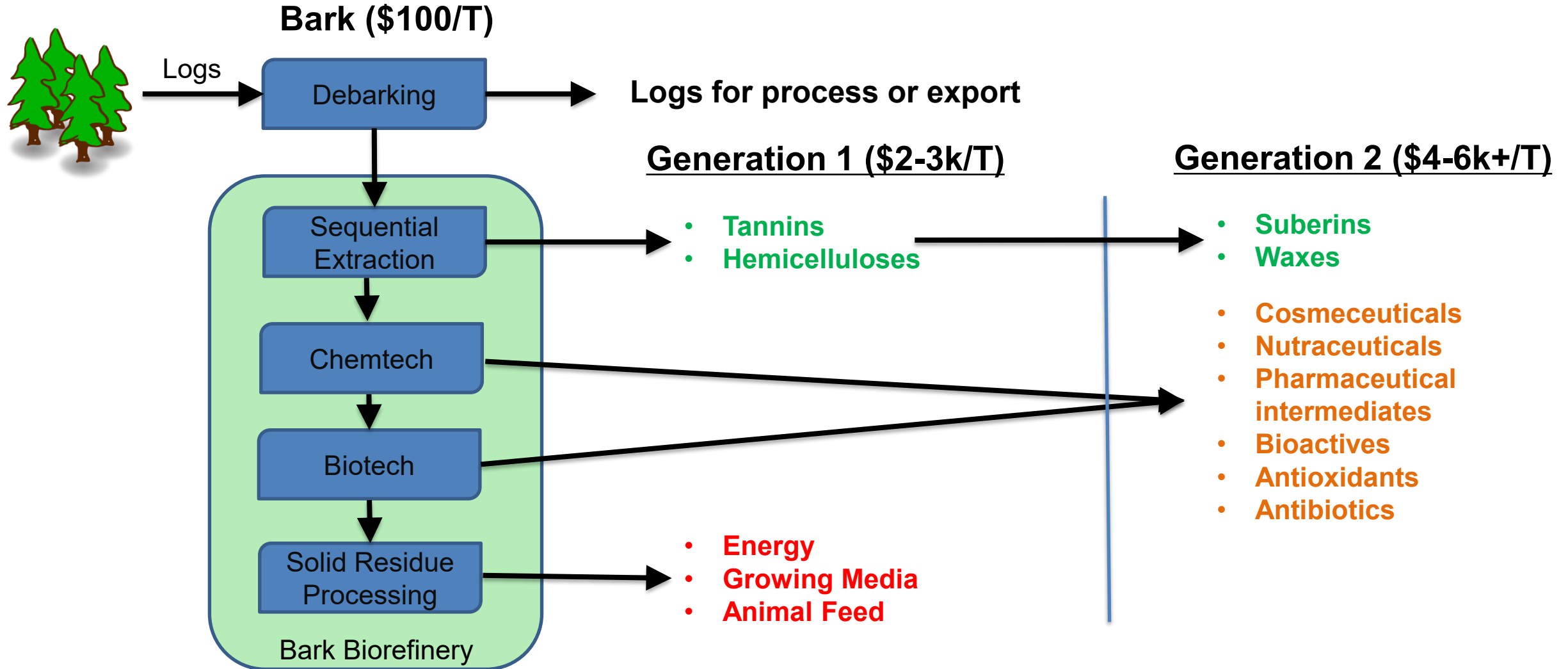
87% of NZ plantation forests by area are *Pinus radiata* (15,000 km<sup>2</sup>)

- Total NZ plantation forest harvest for the year ending March 2020 was 32.9M m<sup>3</sup>
- Of that 29.6M m<sup>3</sup> was *Pinus radiata*

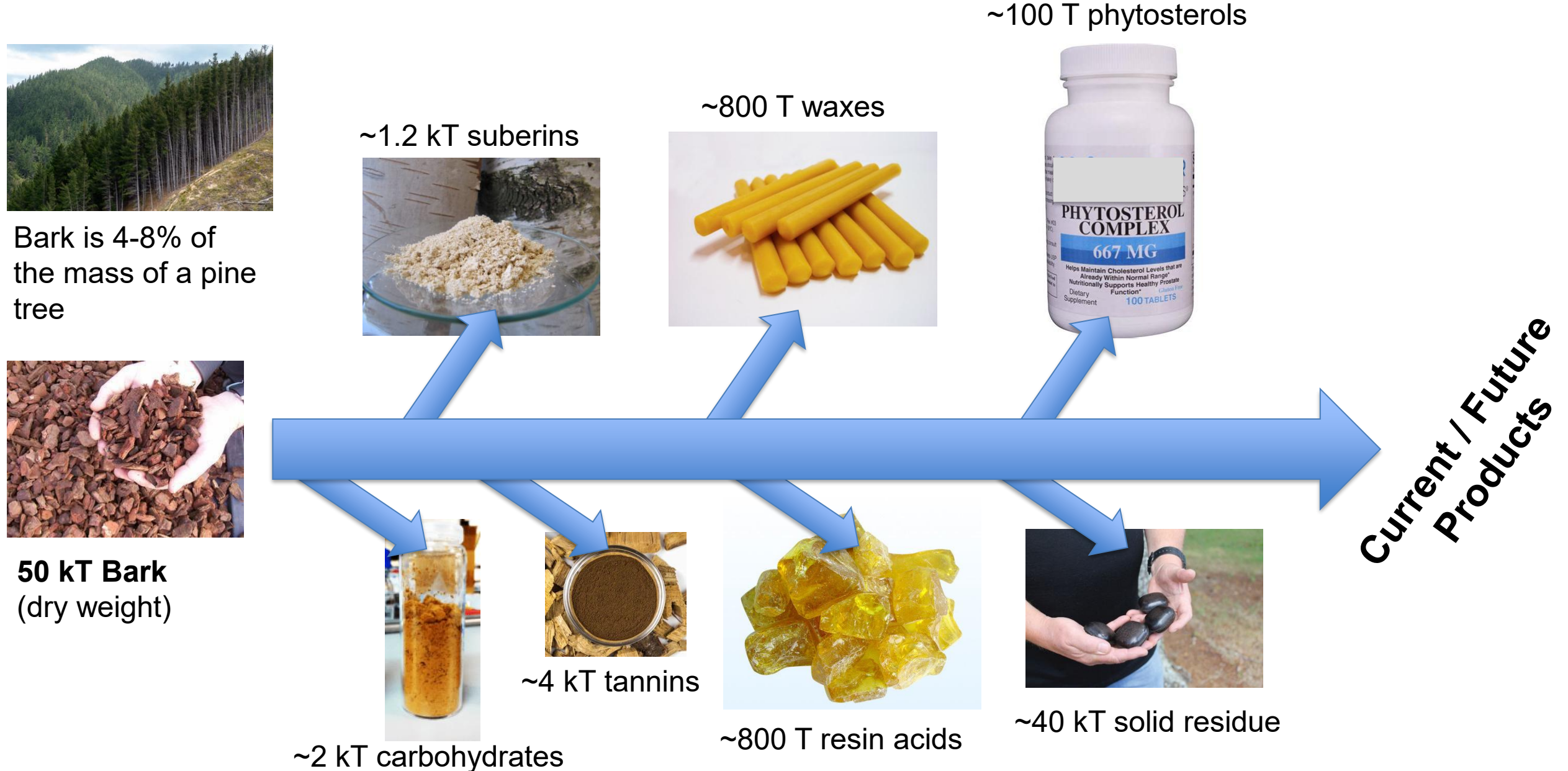




# Bark Biorefinery - concept

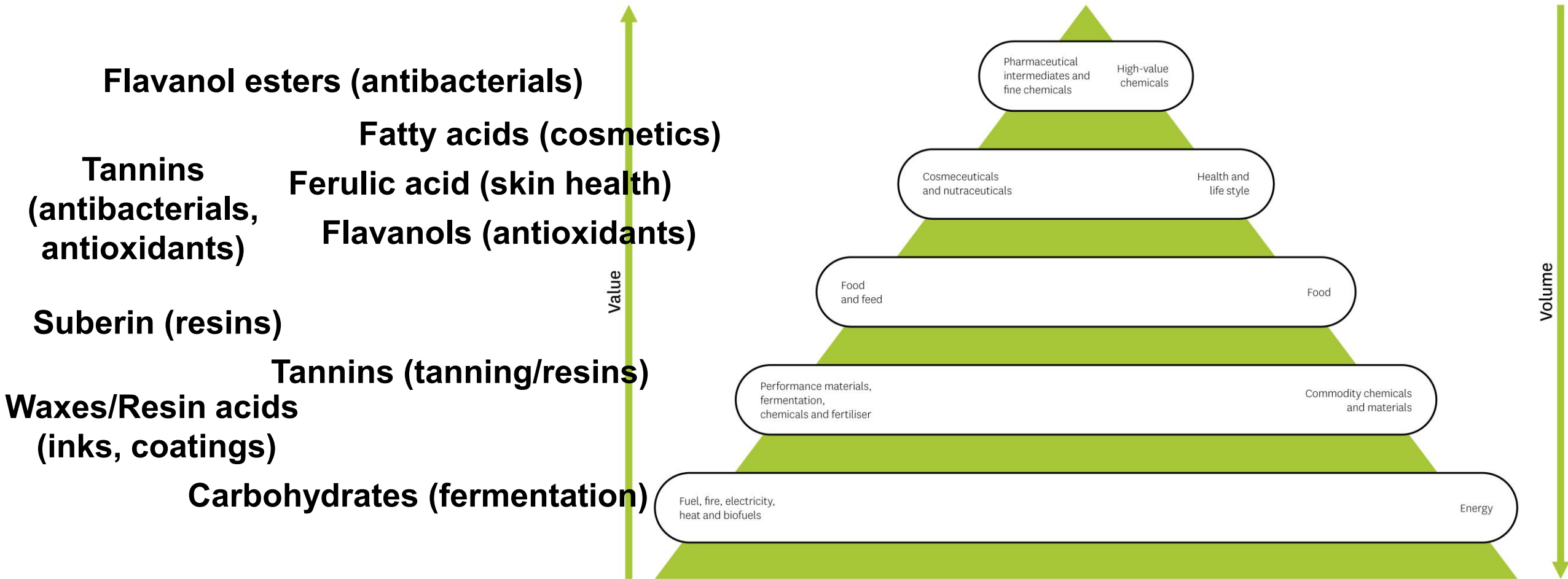


# Integrated Bark Biorefinery - mass balance



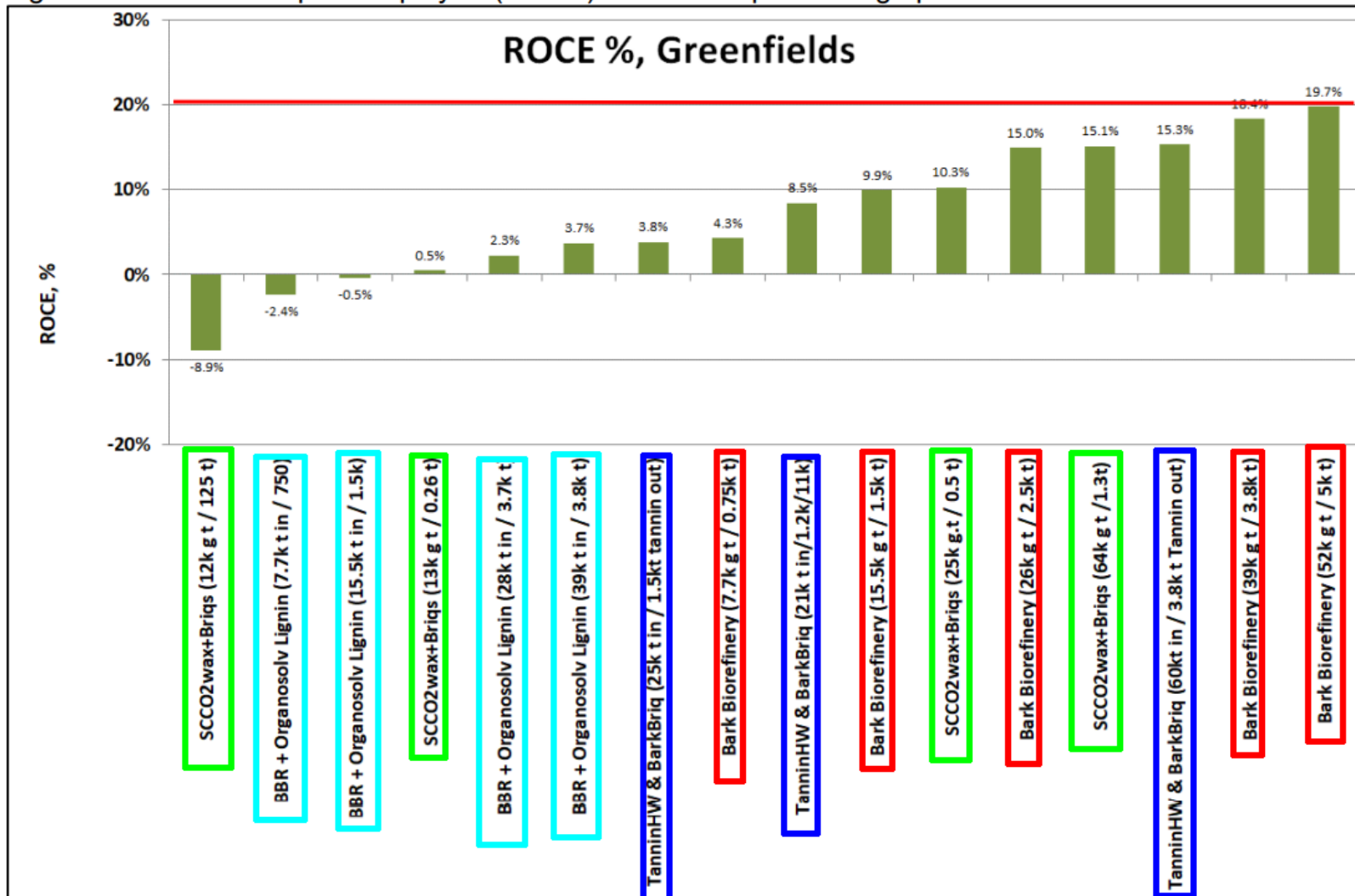


# Value Pyramid – Bark Biorefinery (NZ 2030)



# Integrated Bark Biorefinery - ROCE

Figure 1 – return on capital employed (ROCE) for 25 bark processing options



# Bark Biorefinery - mass balance



Bark is 4-8% of the mass of a pine tree



**50 kT Bark**  
(dry weight)

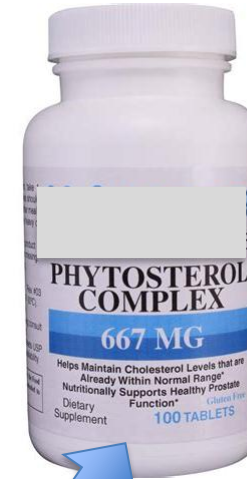
~1.2 kT suberin



~800 T waxes



~100 T phytosterols



**Current / Future  
Products**

~2 kT carbohydrates



~4 kT tannins



~800 T resin acids



~40 kT solid residue





# From Lab Scale... to Pilot Plant Scale to...



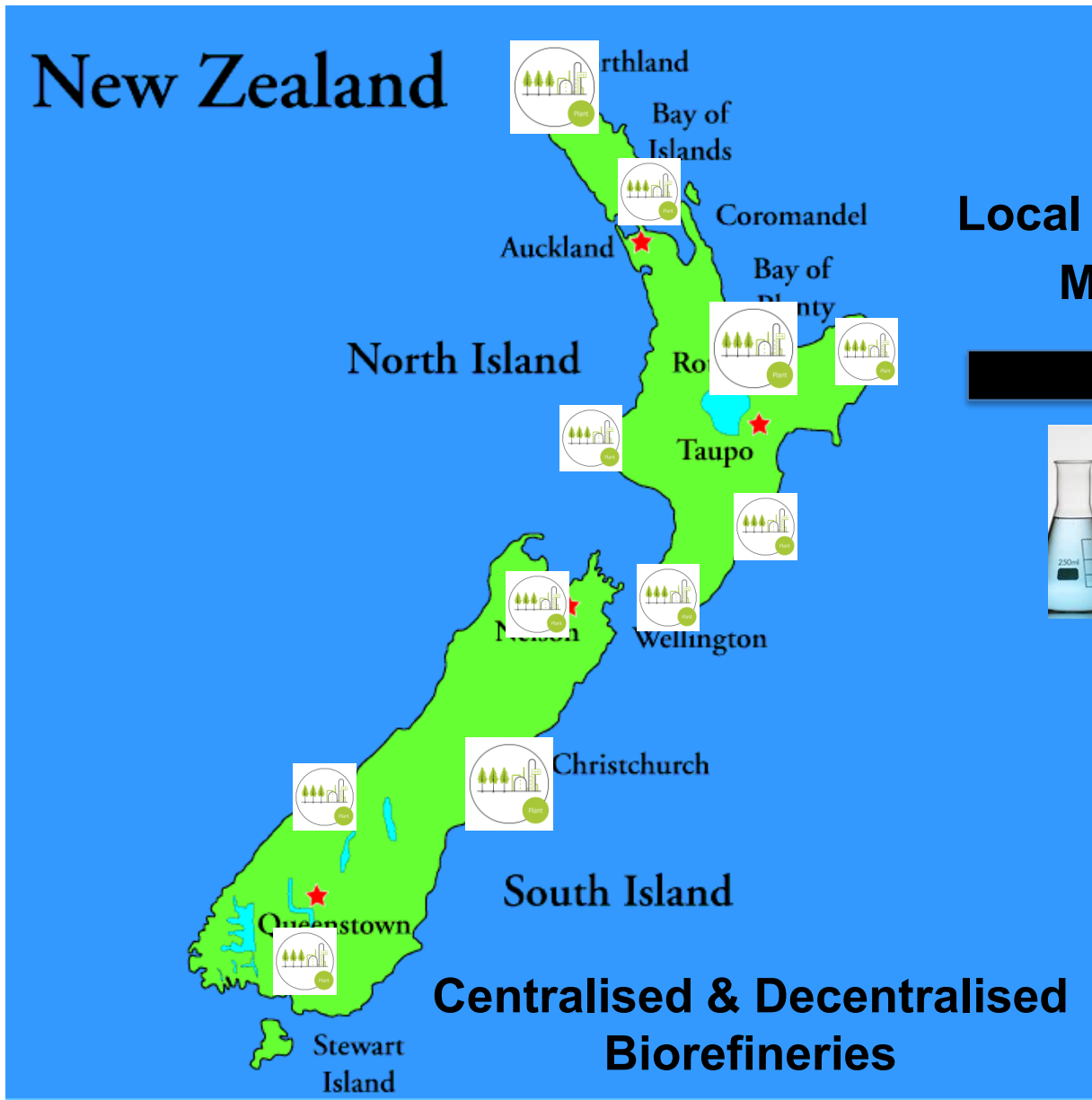


## ...To Final Demonstration Product



Shoes made  
by McKinlays

# The future: A tree driven NZ chemical circular bioeconomy



**Local and Global Markets**



**The top 5 oil refineries produce up to 89M L refined oil / day that go to make chemicals and materials.**

- **Huge opportunity for Biorefineries**



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Prosperity from trees *Mai i te ngahere oranga*

Scion is the trading name of the New Zealand Forest Research Institute Limited