

Rethinking Biorefineries for New Zealand:

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

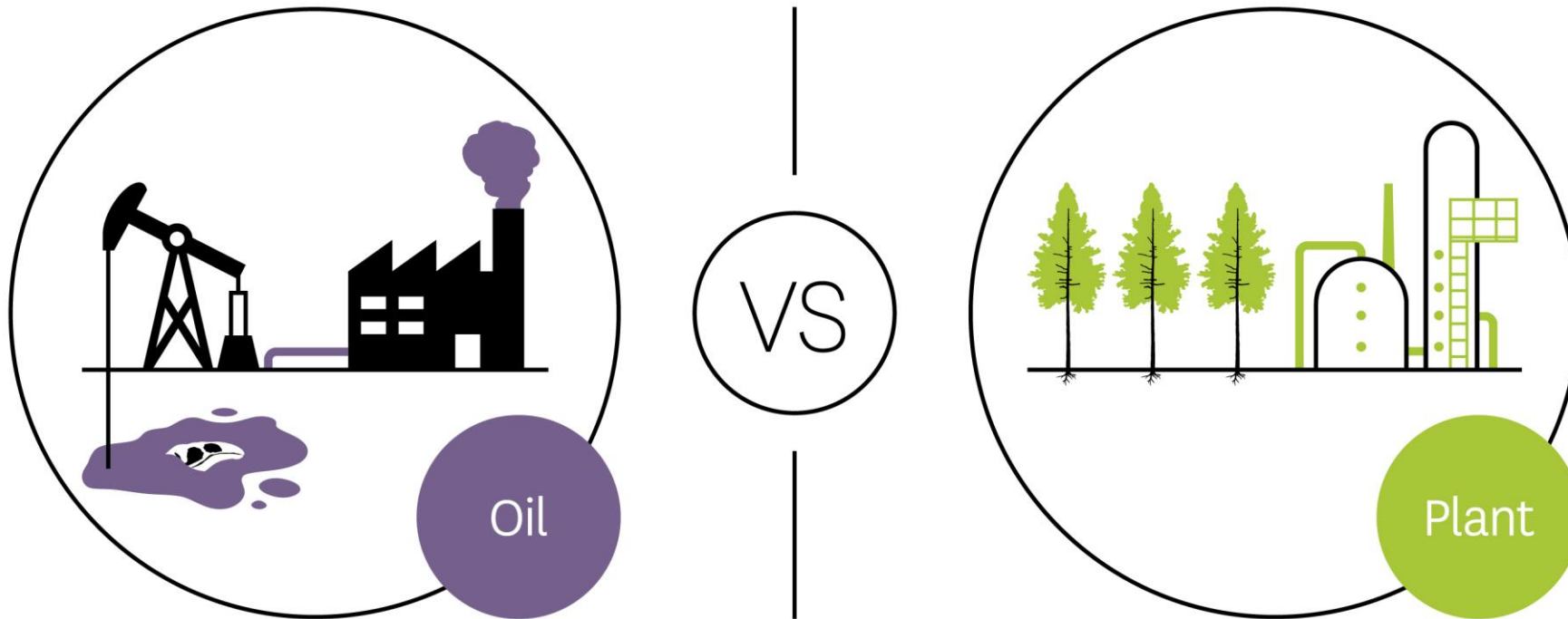


Marie Joo Le Guen

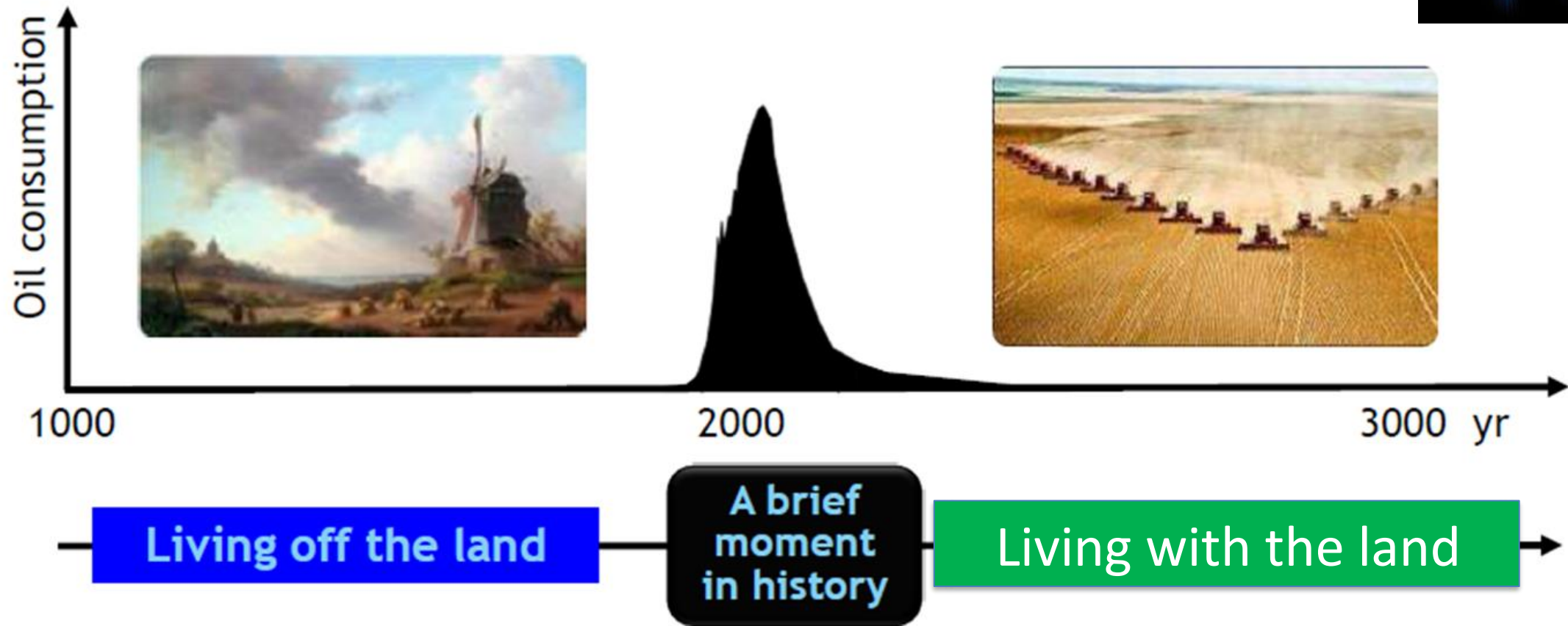
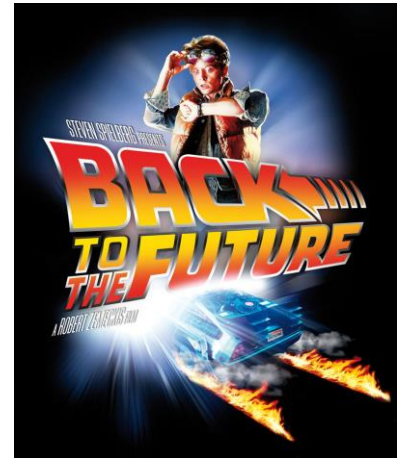
12th Asia International Conference On Leather Science And Technology
18 October 2022 in Palmerston North, New Zealand

Oil-based vs Tree-based feedstock for refining

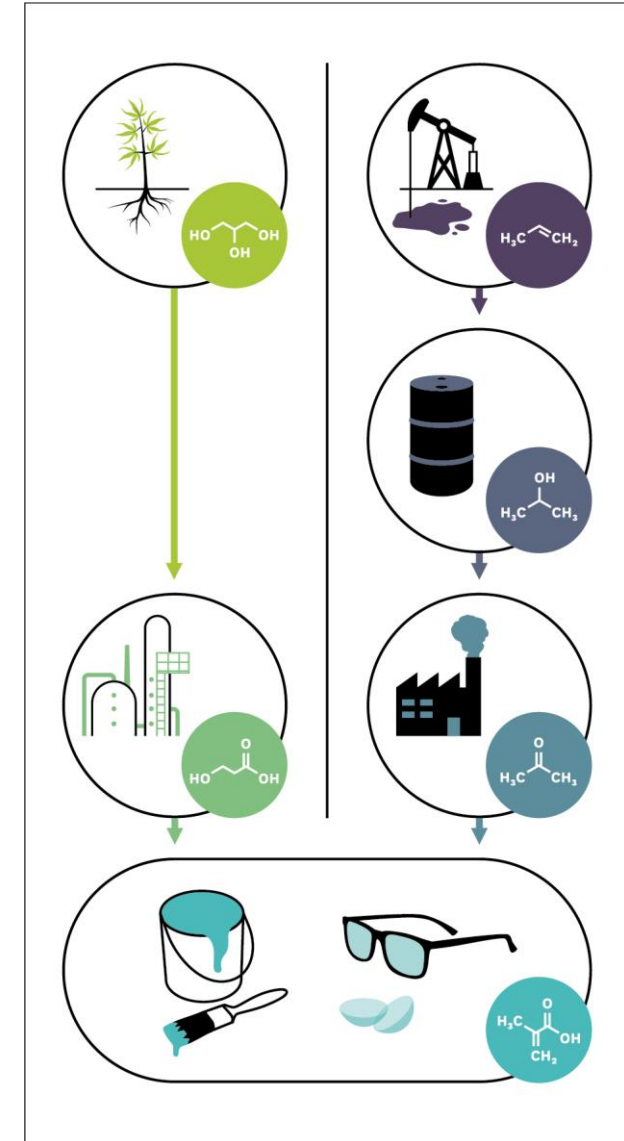
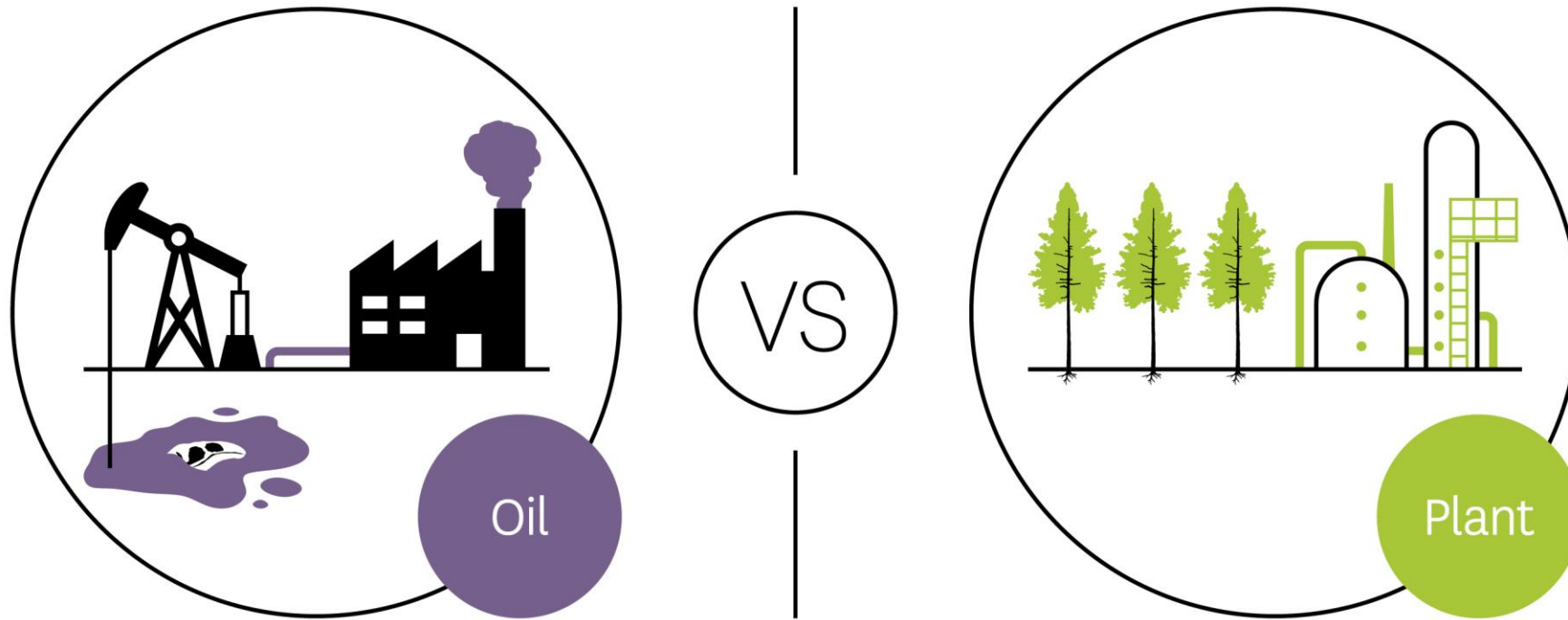
Using unsustainable resources from underground or sustainable resources from above ground



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....



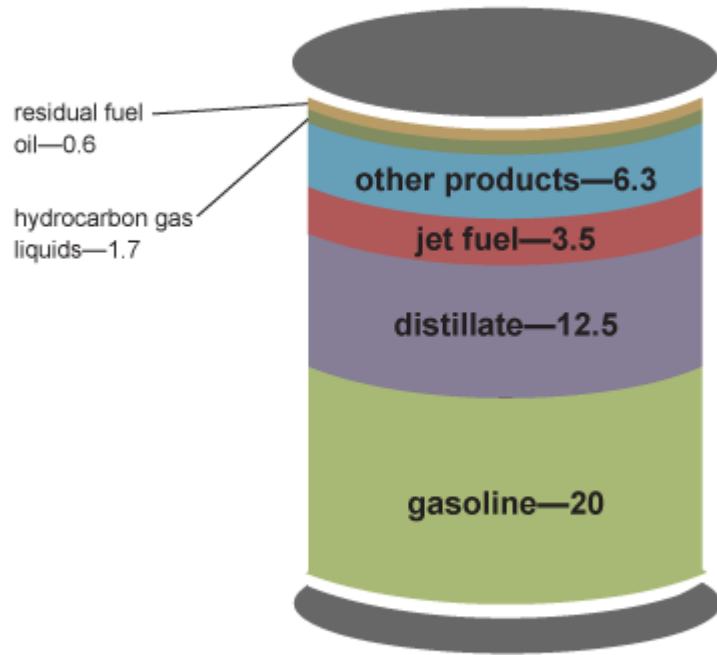
...and the Oil
Age will end
long before the
world runs out
of oil



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

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.

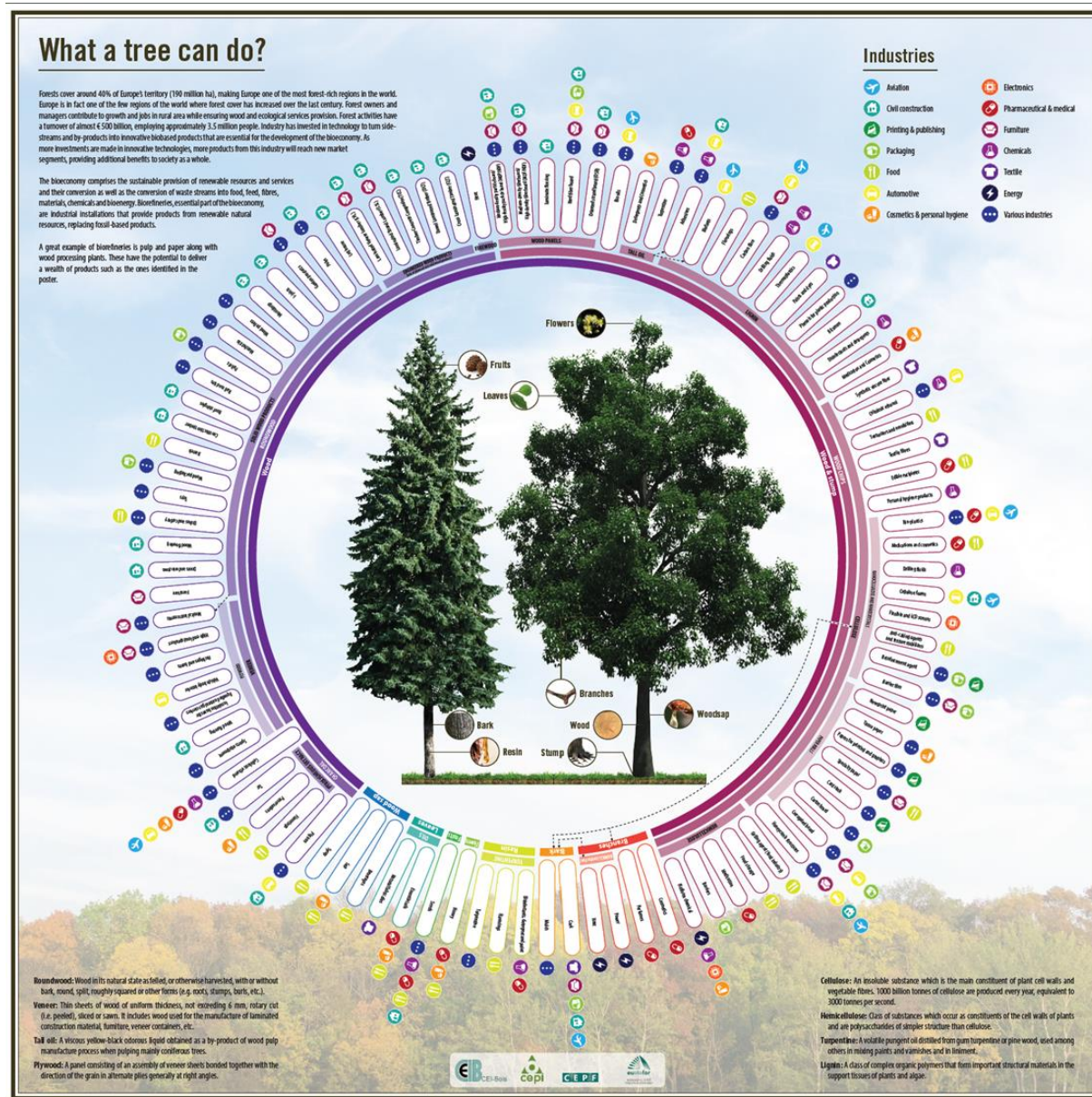
Adhesives and sealants
Agrochemicals
Construction chemicals
Corrosion control chemicals
Cosmetics raw materials
Electronic chemicals and materials
Flavourings, fragrances, food additives
Pharmaceutical drugs
Specialty and industrial chemicals
Specialty and industrial gases
Inks, dyes and printing supplies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

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



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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 Whaihua

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

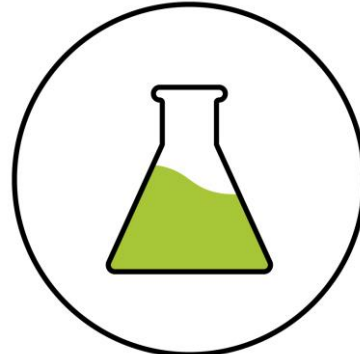
High-value chemicals



Cosmeceuticals



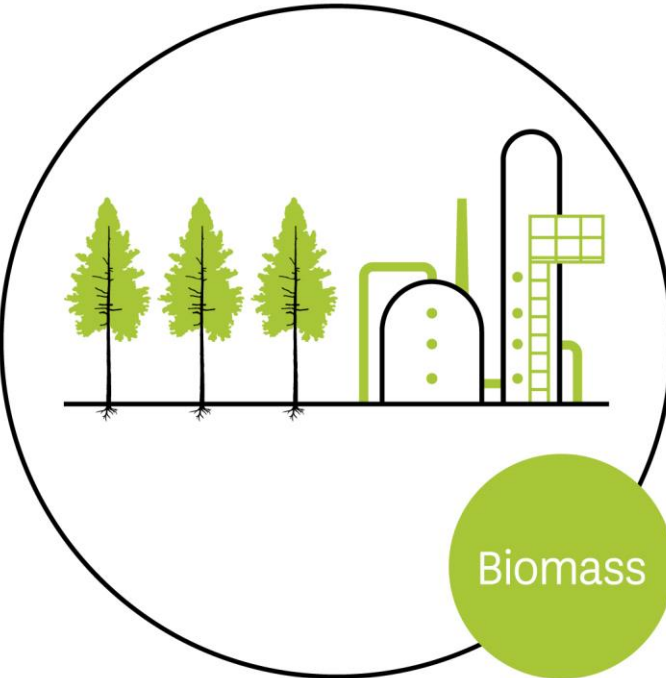
Nutraceuticals



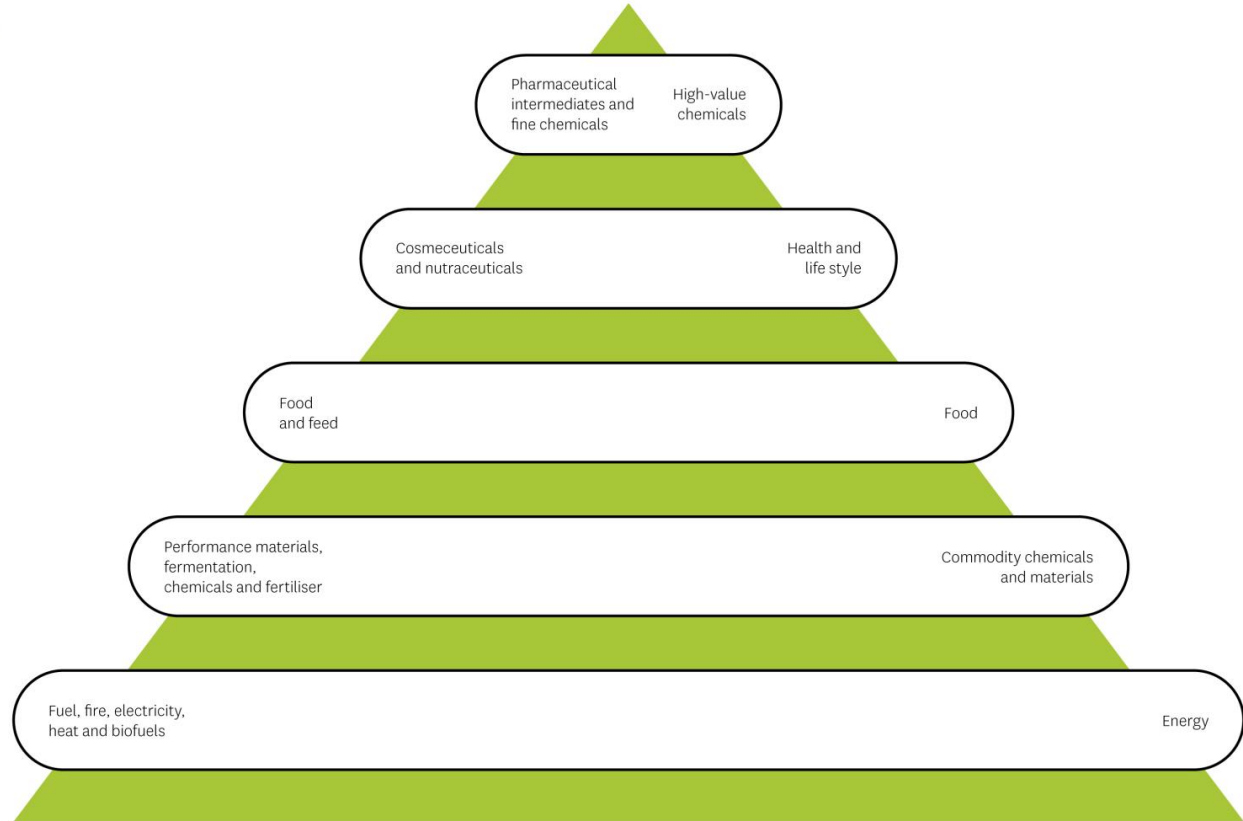
Fine
Chemicals



Pharmaceutical
Intermediates



Value ↑



New Zealand case study – A Bark Biorefinery

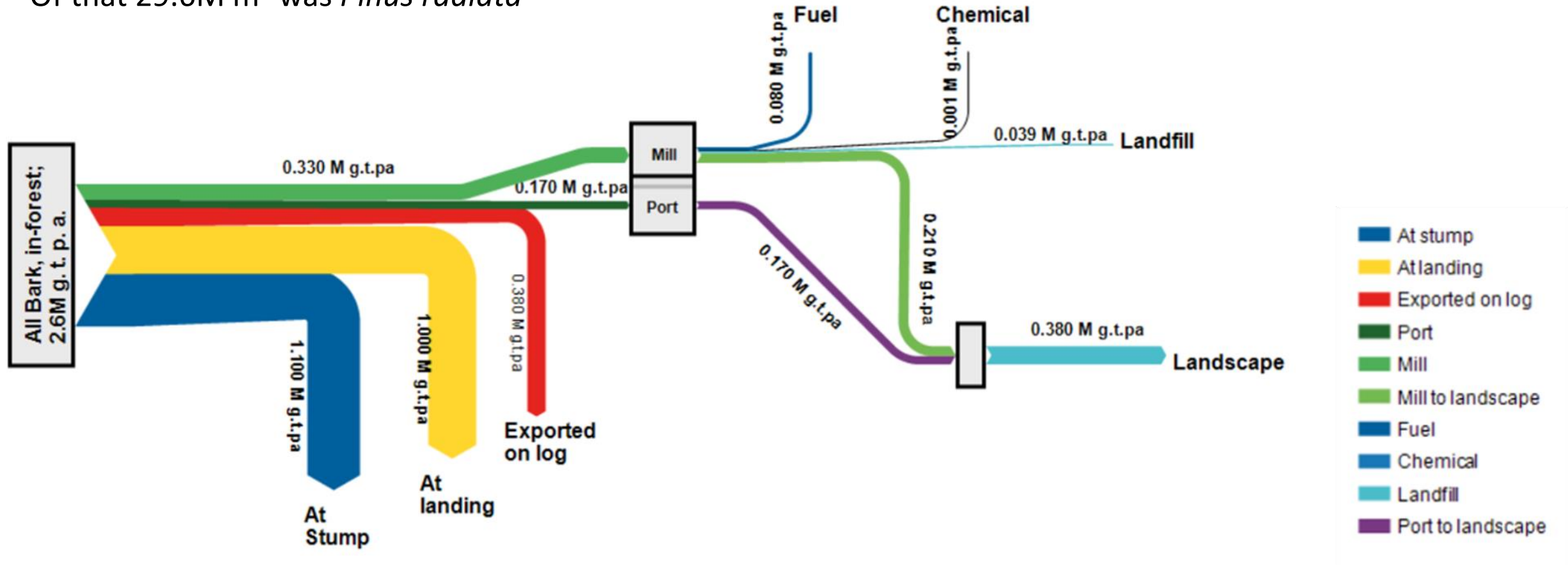
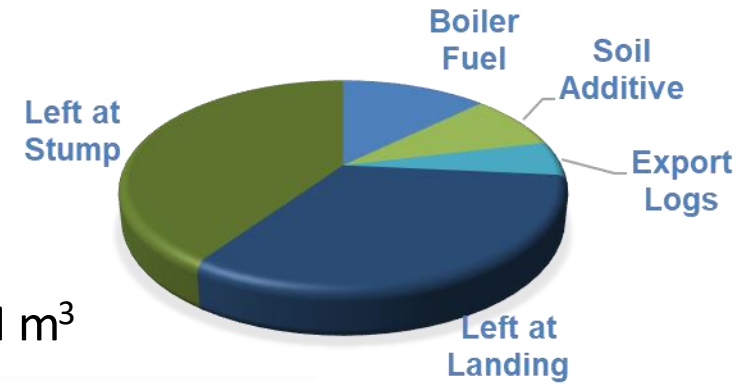
- 5-year Scion led MBIE funded Programme (2018 – 2023)
- Focus on delivering a Pine Bark based Biorefinery
 - A range of products from commodity to high-value
 - Zero waste by converting solid residue into bark briquettes
- Partnering with forestry, bark suppliers, large scale extraction capability,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



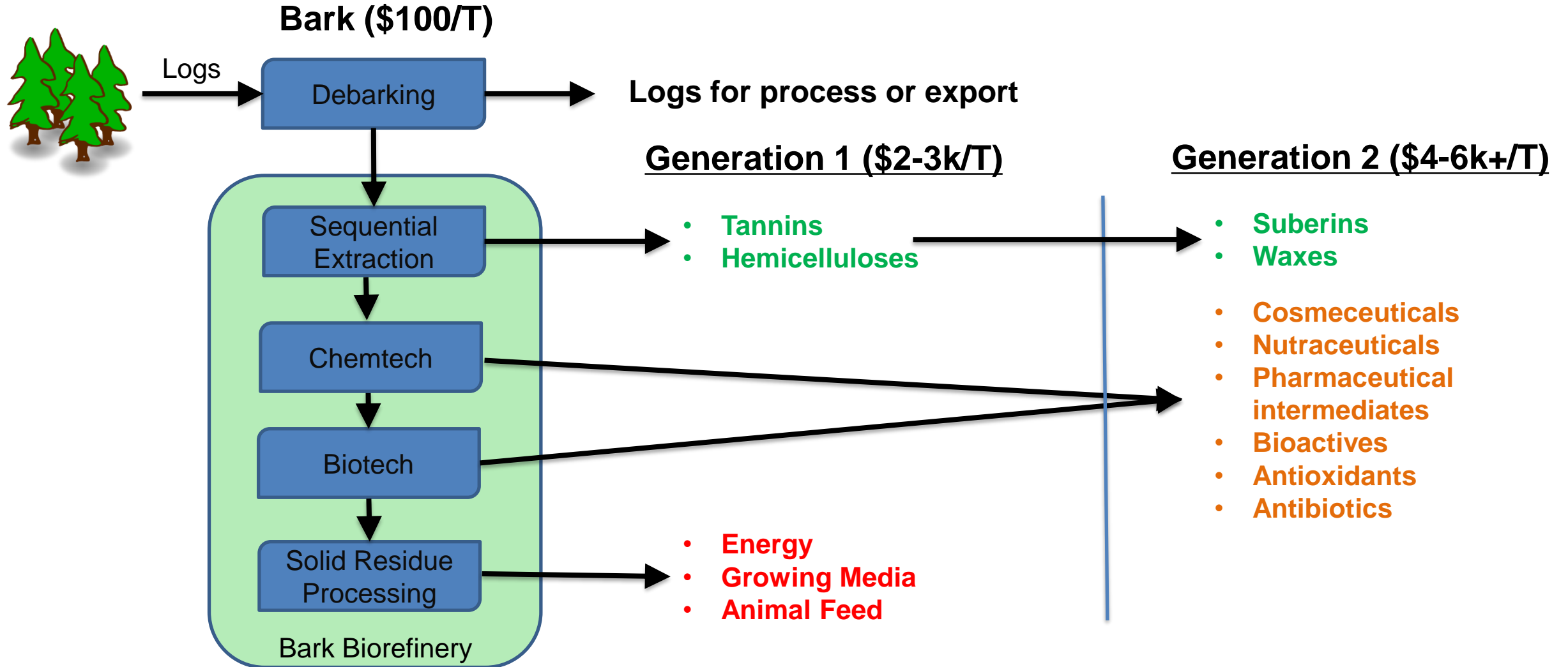
Bark Biorefinery - mass flow

87% of NZ plantation forests by area are *Pinus radiata* (15,000 km²)

- Total NZ plantation forest harvest for the year ending March 2020 was 32.9M m³
- Of that 29.6M m³ was *Pinus radiata*



Bark Biorefinery - concept



Integrated Bark Biorefinery - mass balance



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



50 kT Bark
(dry weight)

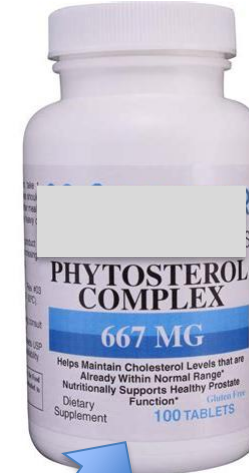
~1.2 kT suberin



~800 T waxes



~100 T phytosterols



**Current / Future
Products**

~2 kT carbohydrates



~4 kT tannins



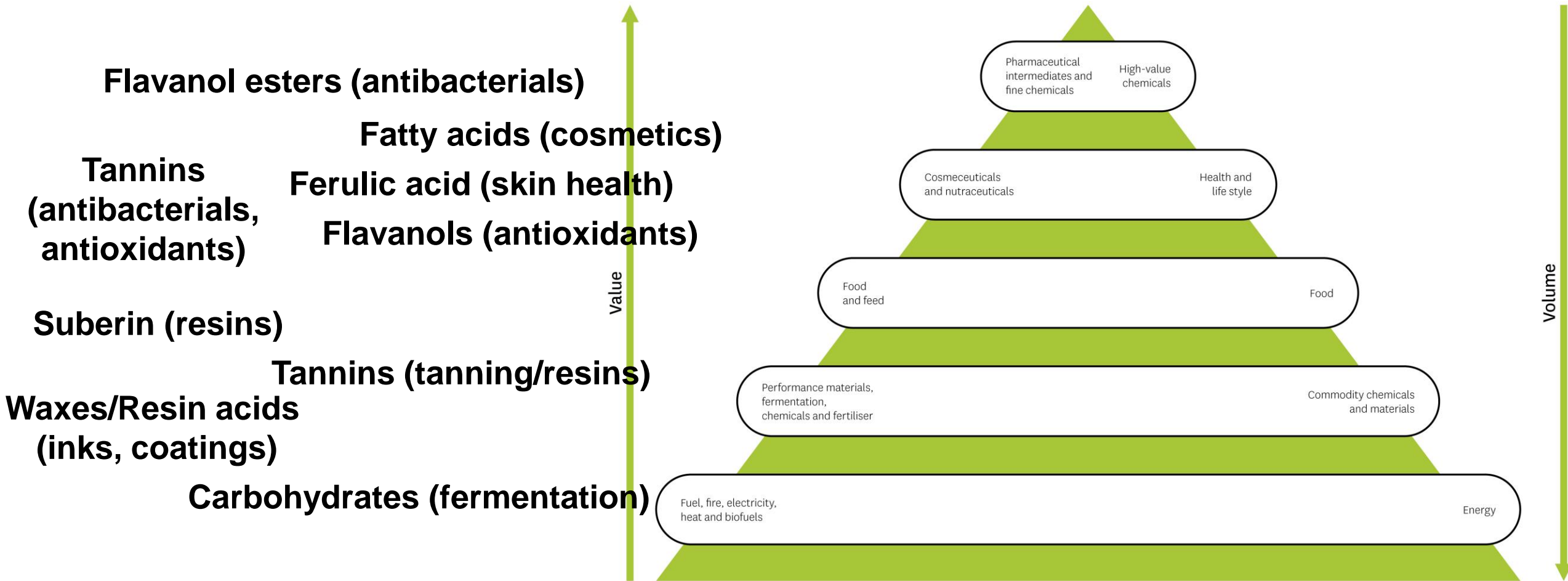
~800 T resin acids



~40 kT solid residue

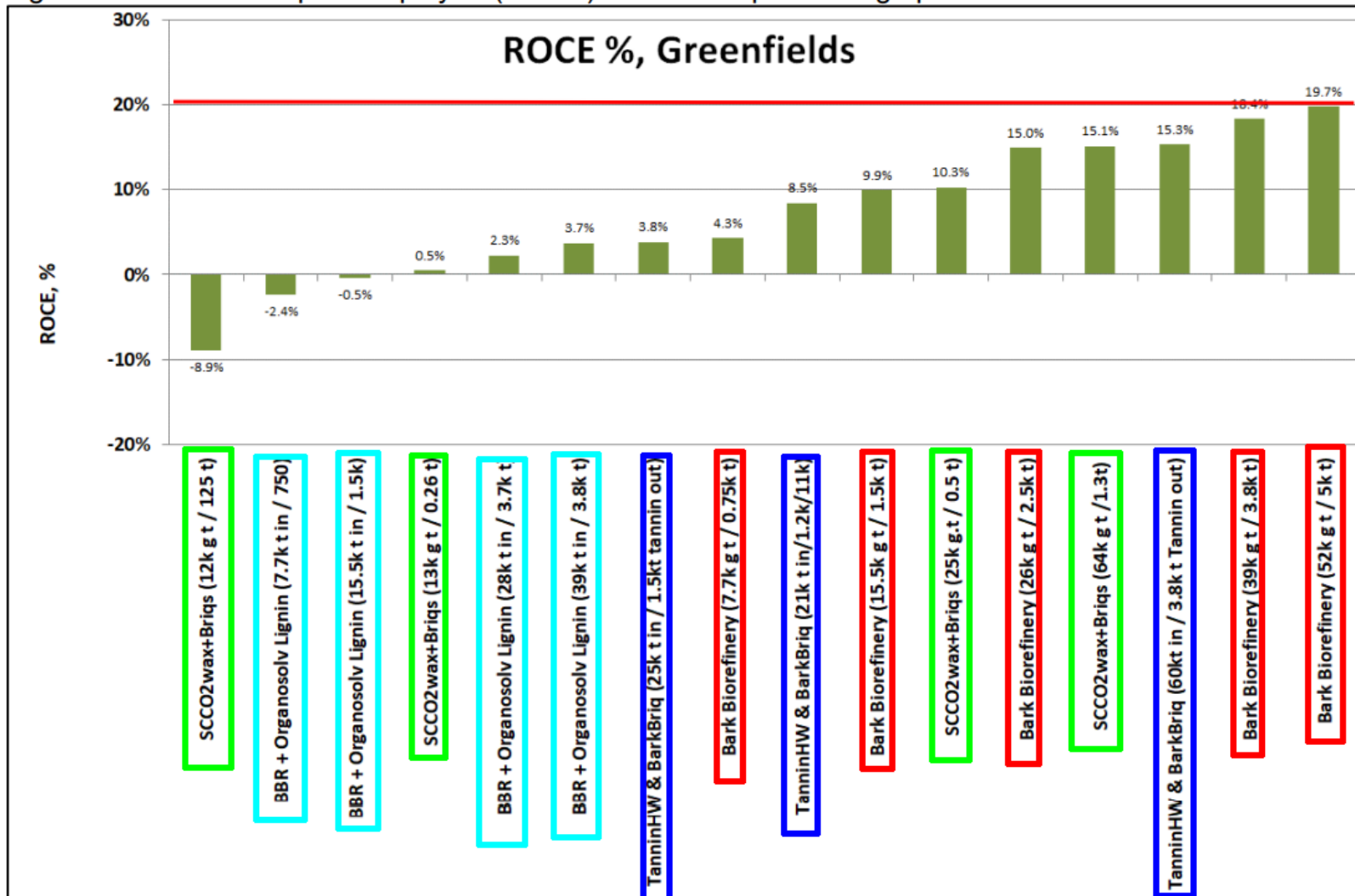


Value Pyramid – Bark Biorefinery (NZ 2030)

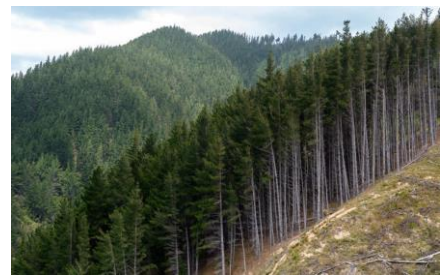


Integrated Bark Biorefinery - ROCE

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



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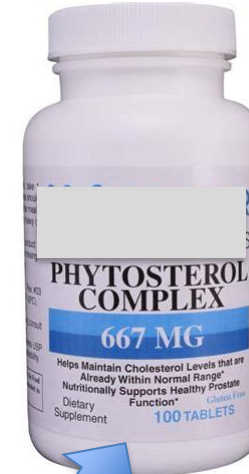
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From Lab Scale... to Pilot Plant Scale to...

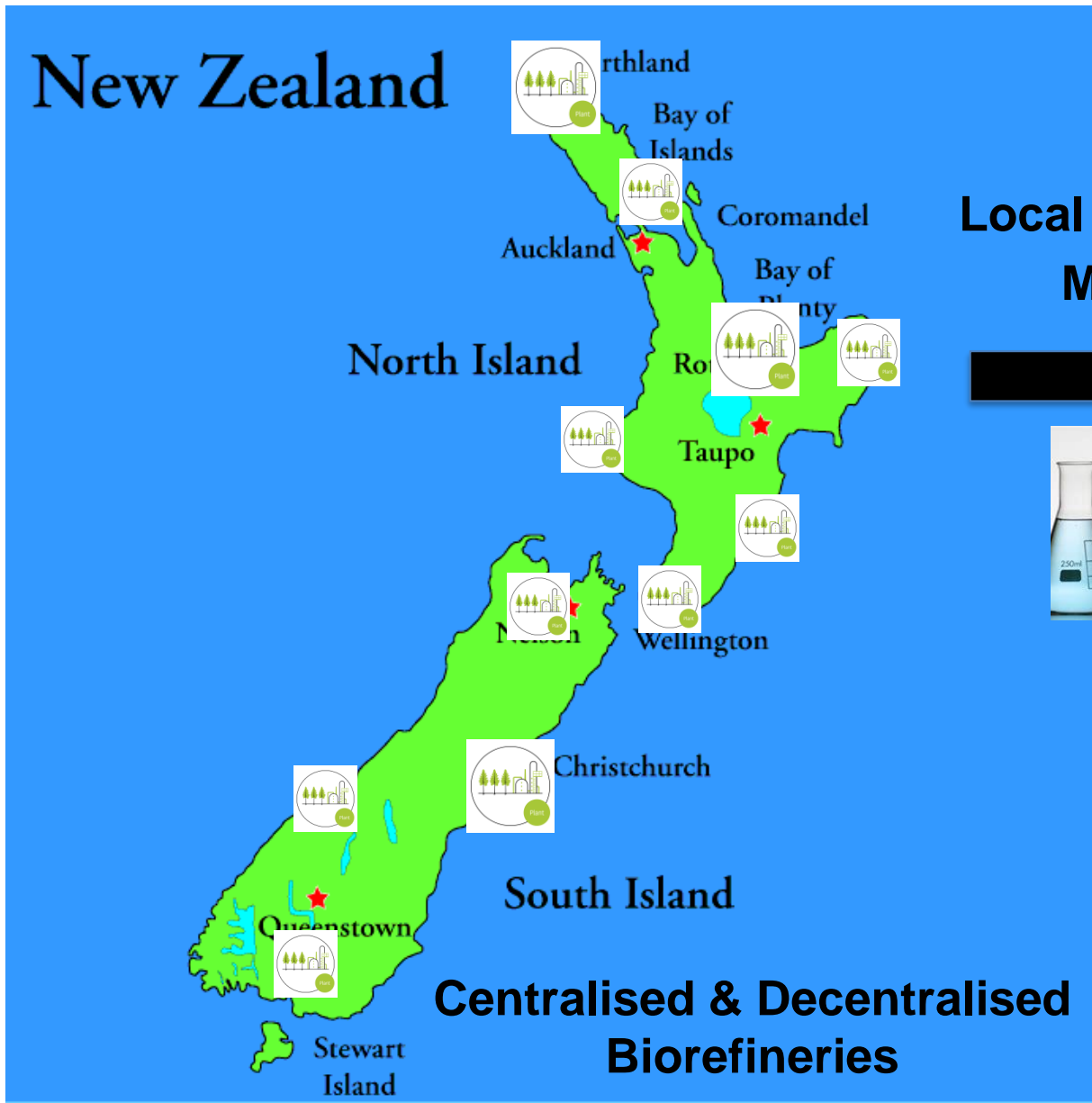


...To Final Demonstration Product

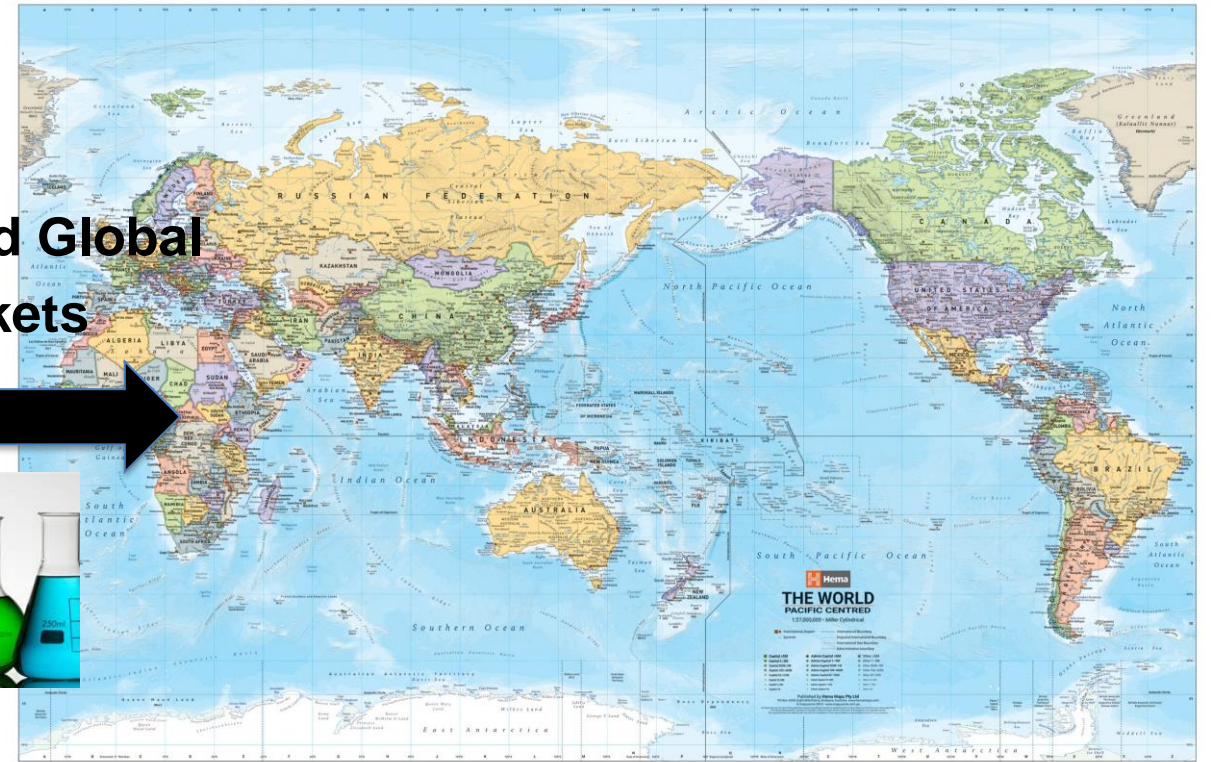


Shoes made
by McKinlays

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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www.scionresearch.com



Prosperity from trees *Mai i te ngahere oranga*

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