

# Advanced biobased products: Combining sustainability with performance

NZIF Conference 2017 - Florian Graichen - Novotel Rotorua – 5 September 2017



# Living beyond our means



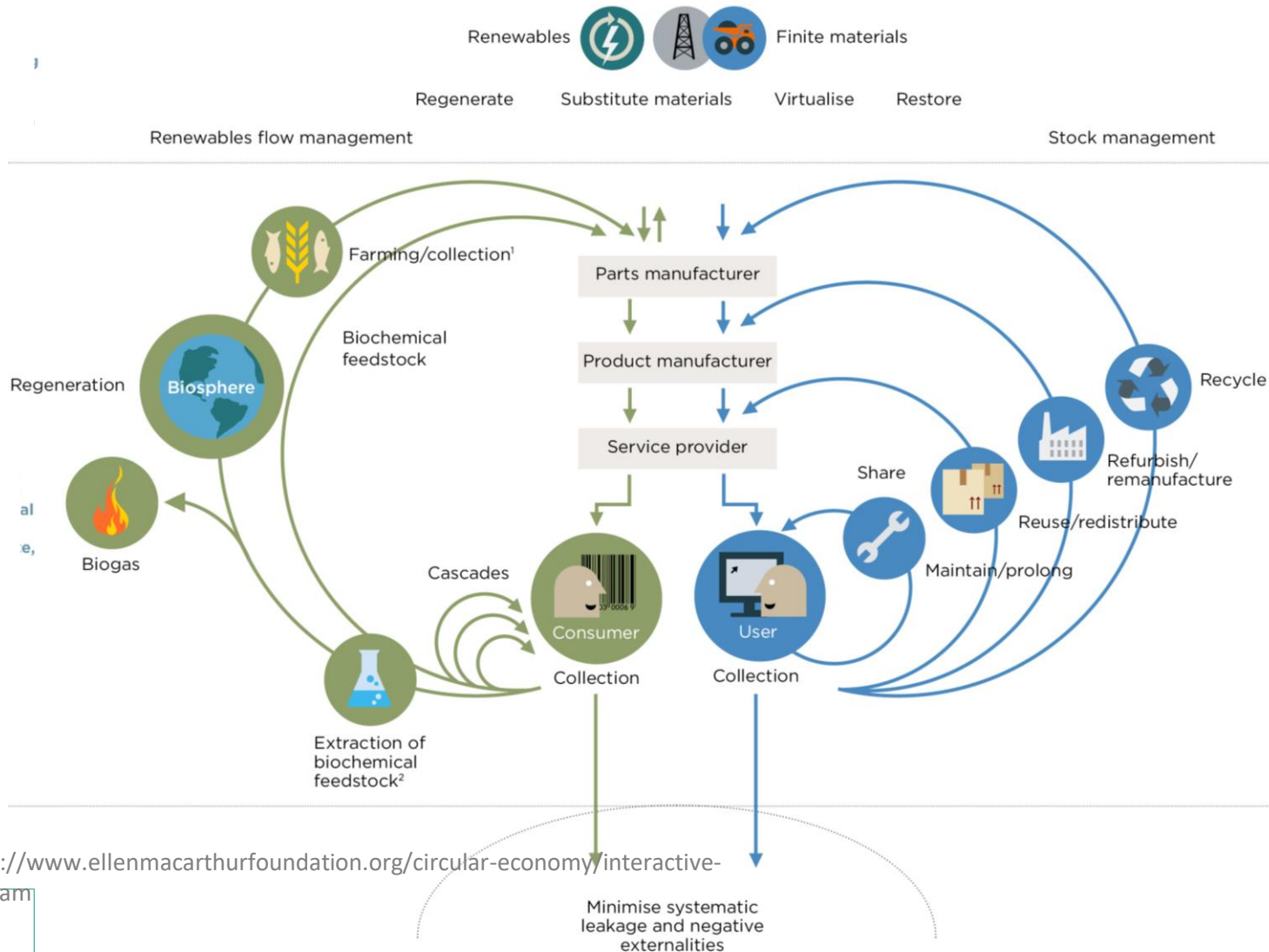
**EARTH  
OVER  
SHOOT  
DAY**

# Outline

- Bioeconomy & Circular economy Drivers
- Scion – Bioproducts - Recent Commercial Examples
  - Biospife
  - Woodforce
  - Ligate
- Summary

# Bioeconomy & Circular economy Drivers

# The solution - a Circular- & Bioeconomy

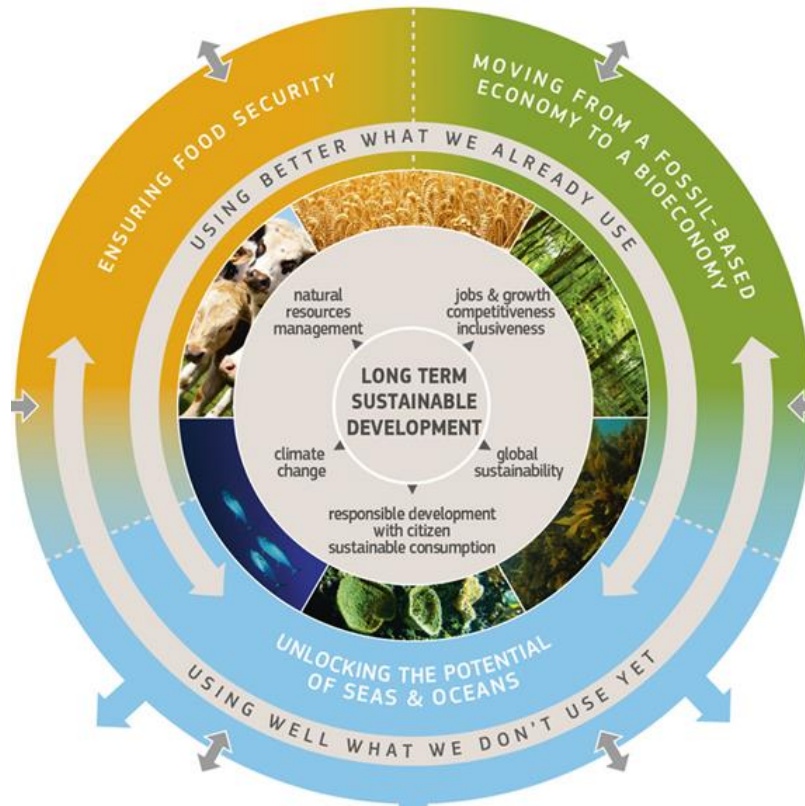


<https://www.ellenmacarthurfoundation.org/circular-economy/interactive-diagram>

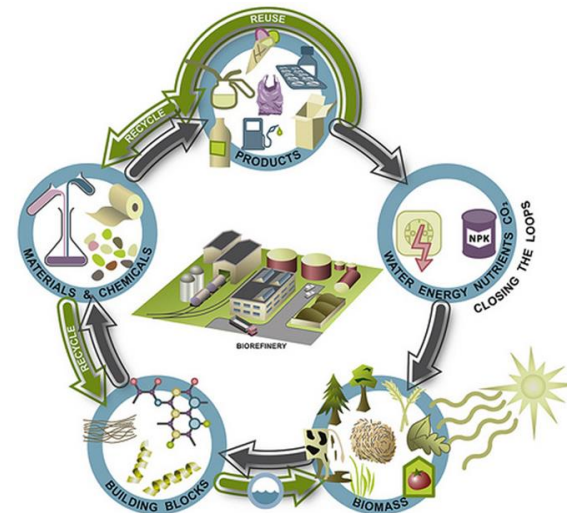
1. Hunting and fishing  
2. Can take both post-harvest and post-consumer waste as an input

Source: Ellen MacArthur Foundation, SUN, and McKinsey Center for Business and Environment; Drawing from Braungart & McDonough, Cradle to Cradle (C2C).

# The Bioeconomy



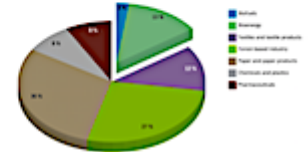
is the production of renewable biological resources and their conversion into food, feed, bio-based products and bioenergy



# Bioeconomy – global priority

The European  
**Bioeconomy**  
**€2trillion**  
and growing fast

Here comes the hard data. Food and beverages. Agriculture. Forestry. Chemicals and plastics. Pharmaceuticals. Paper and paper products. Biofuels and bioenergy.



## US

- ~\$50 billion to biofuels & bio-chemicals
- 2012, President Obama: *"The bio-economy is a major engine for American innovation and economic growth"*



## BRAZIL

- Aims to be N°1 Global Bio-economy
- R\$ 3,3 billion for 2<sup>nd</sup> generation bioethanol, bio-chemicals and biomass gasification technologies



## CHINA

- > \$300 billion in Science & Technology with biotech as a major priority over 2011-2015
- Substitute 20% of crude oil imports by 2020

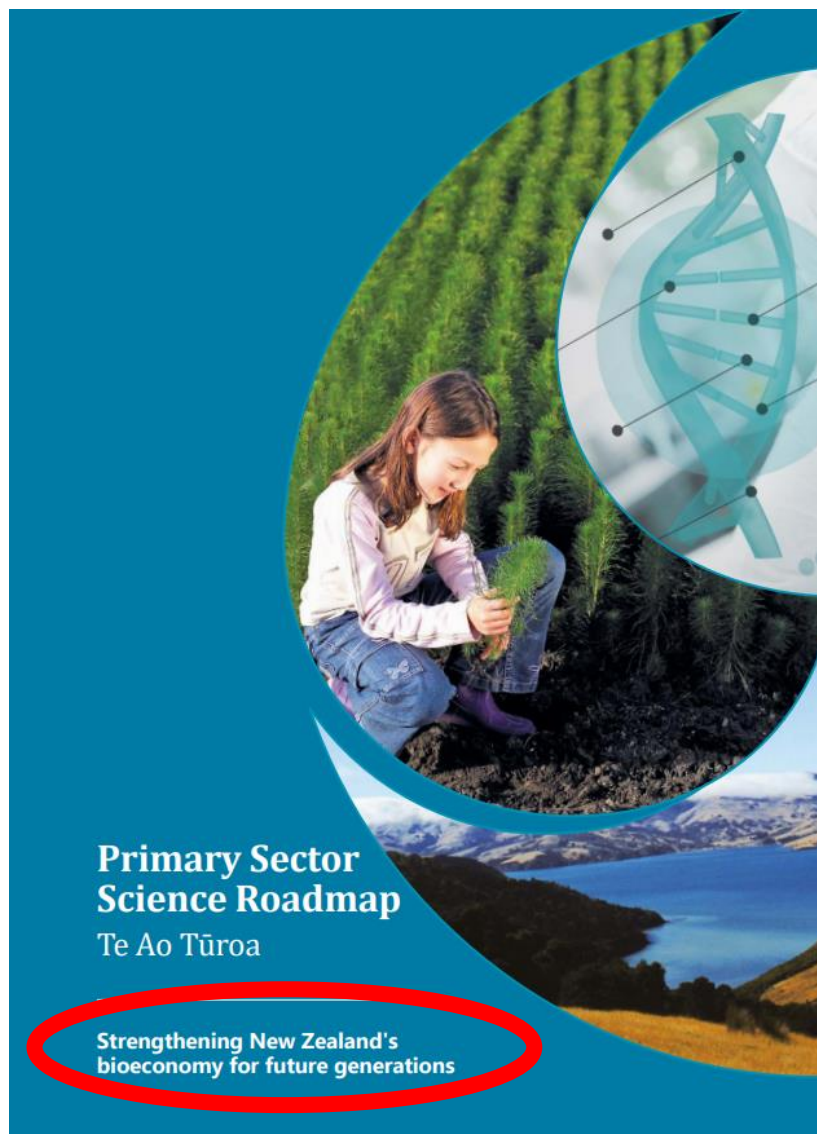


# New Zealand – already a bioeconomy



# Primary Sector Science Roadmap

## Te Ao Tūroa



### Primary Sector Science Roadmap

Te Ao Tūroa

Strengthening New Zealand's  
bioeconomy for future generations

Sustaining, protecting and adapting  
our natural resources

Growing productivity and profitability with  
environmental, social and cultural acceptability



High-value products for  
consumers

Integrating primary production systems,  
people, communities and values

<http://www.mpi.govt.nz/news-and-resources/science-and-research/primary-sector-science-roadmap-te-ao-turoa/>

# Scion – Bioproducts - Recent Commercial Examples

# What is happening in the world?

LATEST NEWS

## Metsä Group started up its bioproduct mill



Metsä Group's new plant will make the company the world's biggest producer of softwood pulp, © Metsä Group

The mill will be a platform for production of new bio-based products:

- lignin products
- textile fibres
- biocomposites.

# Brandowner Sustainability Messages

## Brandowner sustainability messages

### Consumer products



**IKEA** (2015 sustainability report)

By August 2020, all plastic material used in our home furnishing products will be 100% renewable and/or recycled.



**LEGO** (Responsibility Report 2015)

Invested DKK 1 billion to find a solution for using sustainable materials in all core LEGO® products & packaging by 2030.

### Automotive



**Ford** (2015/15 Sustainability Report)

Improve resource efficiency by replacing petroleum and other nonrenewable resources with plant-based materials.



**TOYOTA**

**Toyota** (2015 Sustainability Report)

Reduce consumption of dwindling natural resources through use of renewable resources and recycled materials.

### Retailers

**WAL-MART**

**Walmart** (2015 Global Responsibility Report)

Shifting towards renewable energy, driving energy and fuel efficiency, managing refrigerants, & diverting operational waste from landfills



**Tesco**

Minimising waste, promoting recycling & redesigning packaging (lighter/less/compostable).

### Food & beverages



**Coca Cola** (2014/15 Sustainability Report)

Goal to use 1st-gen PlantBottle packaging (up to 30% plant-based material) for all new PET plastic bottles by 2020.



**Danone** (Annual Financial Report 2014)

Packaging end of life: turning waste into resources. Expanding collection and recycling of its packaging. Packaging development complies



**Starbucks** (Global Responsibility Report 2014)

Reusable & recyclable cups, with front-of-store recycling. Energy & water conservation. LEED credits for buildings.



**McDonalds** (2014 Good Business Report)

2020 goal to increase amount of in-restaurant recycling to 50% and minimize waste.

### Consumer electronics



**Apple** (Environmental Responsibility Report 2015)

Minimizing the environmental impact of raw materials by using more recycled, recyclable, & sustainable plant-based materials.

**PHILIPS**

**Phillips** (Sustainability Report 2014)

Six key green focal areas: Energy, Packaging, Substances, Weight & Materials, Circularity & Lifetime (EcoDesign process, introduced in 1994).

# 3 Examples – Bioproducts @Scion

Biospife



Woodforce



LIGATE



# Kiwifruit side streams in products



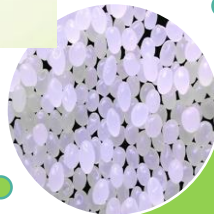
# The Zespri Biospife



Moulding



Compounding



PLA



Kiwifruit skin



# 3 Examples – Bioproducts @Scion

Biospife



Woodforce



LIGATE



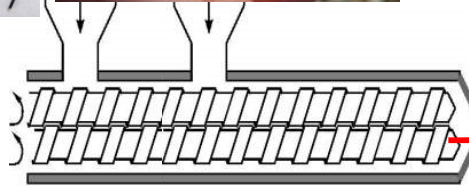
# Wood Fibre Plastic Composites



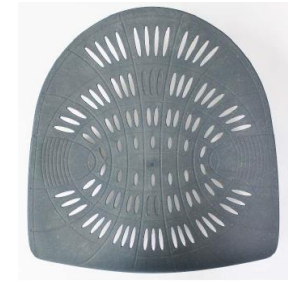
**woodforce**  
lightweight and performance

- 'long' wood fibre reinforced plastics

- Licensed in EU
- Making progress replacing glass-reinforcement in plastics (automotive)



*Ready to use / easy to dose*

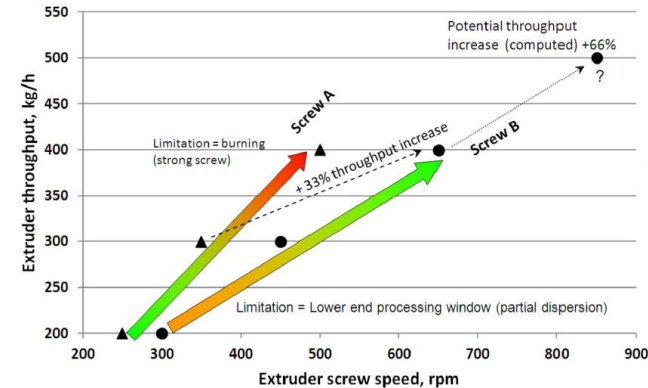


# Advantages; modifications to process

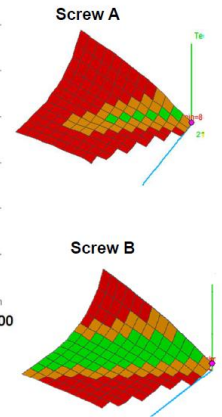
- Lighter (10% - 30% weight saving)
- Improved environmental profile
- End of life/recycling benefits
- Potential cost savings
- Reduced tooling abrasion
- Improved processing cycle times
- Good dimensional stability

## Screw design & throughput: example

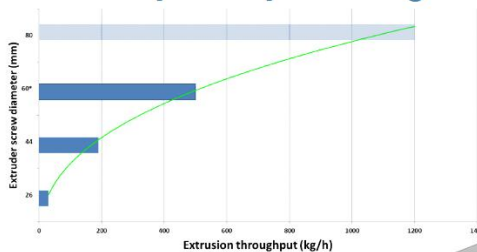
40wt% Woodforce with PP using a 60mm ICMA twin screw extruder



Simulated processing window with Ludovic®



## Scale up Compounding



Industrial scale extruder  
(~500-1000kg/h)



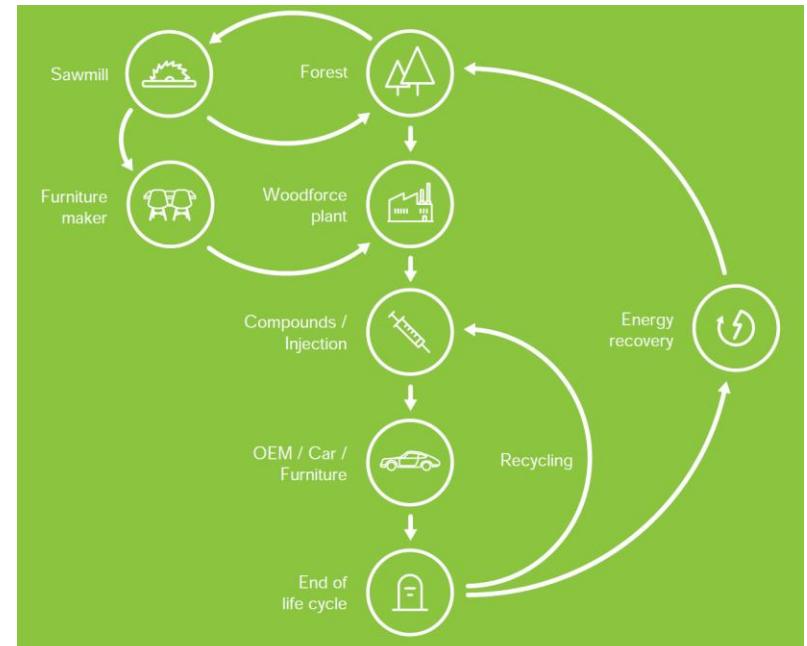
Pilot scale extruder  
(~150kg/h)



Lab scale extruder  
(~20kg/h)

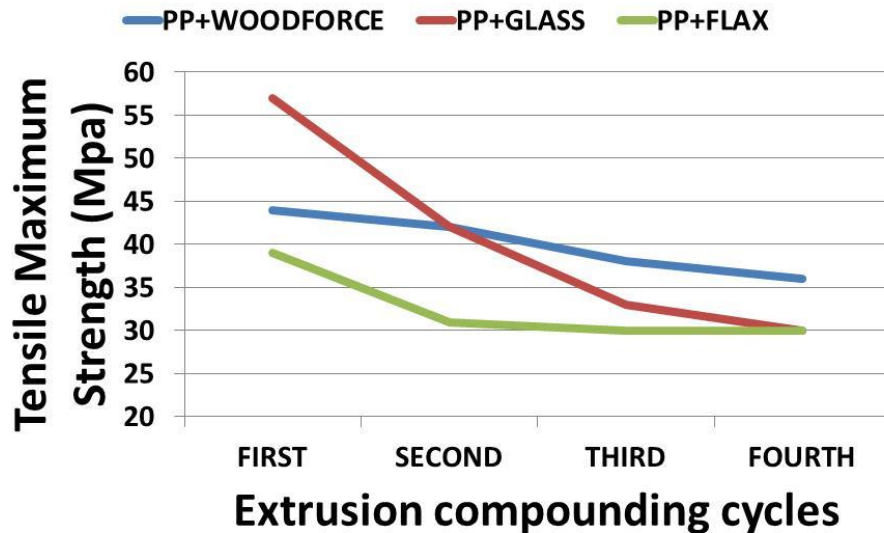


Bench scale extruder  
(~1kg/h)



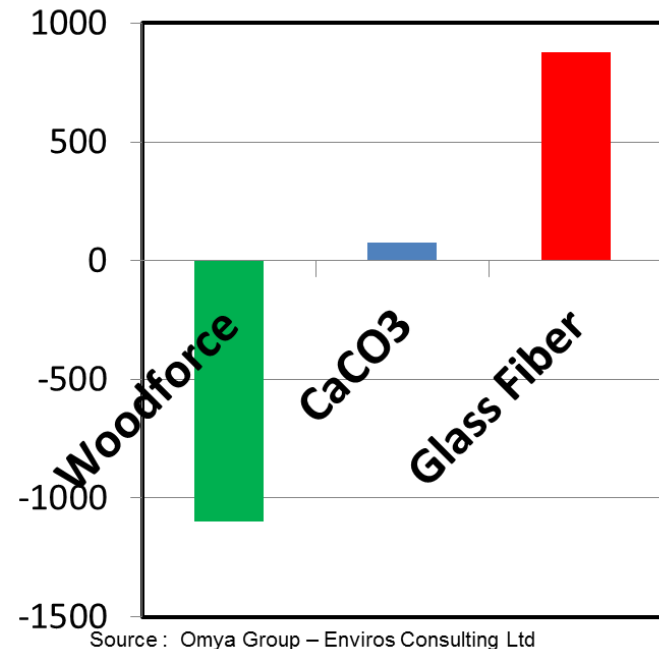
- Light-weighting
- Better recycling
- Lower carbon footprint

## Recycling performance



NB with reactive extrusion = strength 40%WF-PP = 65Mpa

## Carbon Footprint Kg CO<sub>2</sub> /ton of product manufactured



# 3 Examples – Bioproducts @Scion

Biospife



Woodforce



LIGATE



# The wood panel challenge

- Formaldehyde dominates wood adhesives
- Emissions during both manufacture and use

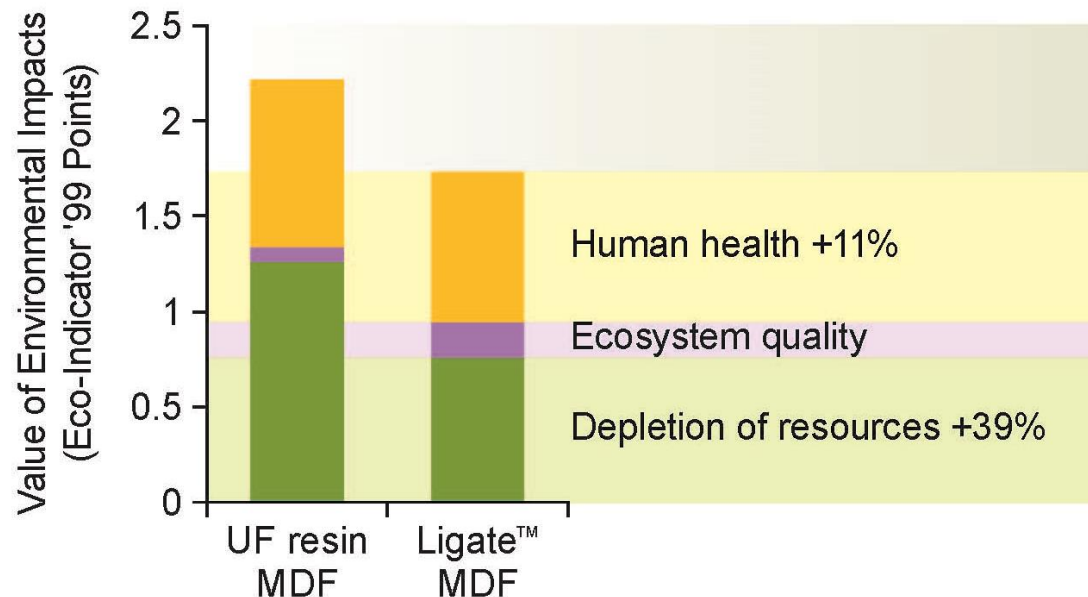


- Consumer awareness of health effects
- Regulation / Certifications
- Sustainable materials demand
- ⇒ Ligate Bioadhesive Development



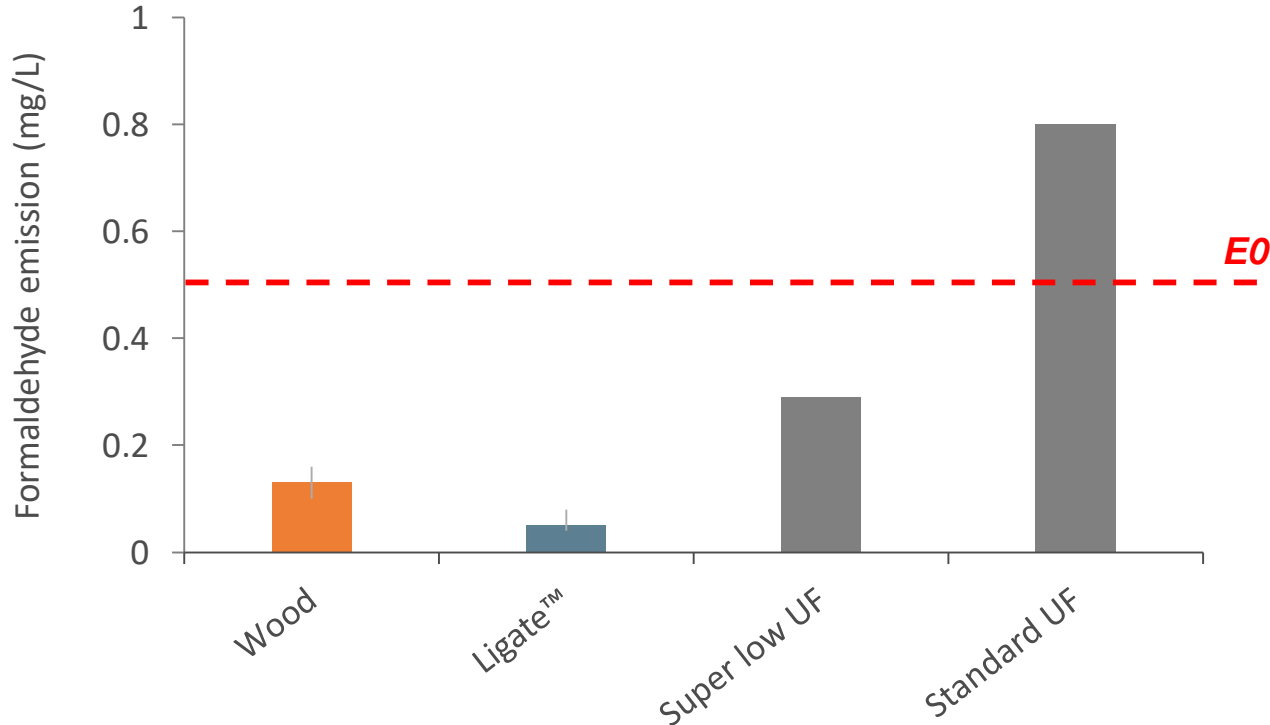
# Renewable - The glue that keeps trees strong is the key to great wood products

- Plant-based ingredients – designed around lignin
- New formulation, not just a substitute
- Avoids petrochemical cross-linkers
- Life cycle impacts



# Breathable - Clean indoor air at home, work and play

- Formaldehyde-free for interiors
- Ligate™ wood panel formaldehyde emissions less than natural wood



Ligate™ 30 mm LVL product had formaldehyde emissions of 0.05 mg/L (0.005 ppm) within 14 days of manufacture (AS/NZS 2098.11, desiccator).

# Useable - Simple to use in existing adhesive and wood product manufacture

## Adhesive manufacture

- Existing infrastructure
- Optional blends



## Panel manufacture

- Direct substitution
- Panel performance
  - ≈ UF resin & interiors

# Summary

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# Read in more detail.....



Industrial Crops and Products

Volume 106, 1 November 2017, Pages 74-85



## Yes, we can make money out of lignin and other bio-based resources

Florian H.M. Graichen , Warren J. Grigsby, Stefan J. Hill, Laura G. Raymond, Marion Sanglard, Dawn A. Smith, Glenn J. Thorlby, Kirk M. Torr, Jeremy M. Warnes

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<https://doi.org/10.1016/j.indcrop.2016.10.036>

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### Highlights

- Size of the product: from designing trees with customised lignin and modifying wood dried by supercritical processing to bioaromatics from lignin hydrogenolysis.
- Scale of the product: from wood fibre plastic composites at commercial scale and lignin-rich bioadhesives to bio-based materials for 3D printing.
- Value of the product(s): lignin-based nanofibres and supercritical extraction of chemicals and compounds to utilising biomass side streams.

Product size	Designing trees with customised lignin	Modifying wood dried by supercritical processing	Bioaromatics from lignin hydrogenolysis
Production scale	Wood fibre plastic composites	Lignin-rich bioadhesives	Bio-based materials for 3D printing
Product value	Lignin-based nanofibres	Supercritical extraction of chemicals	Using biomass side streams

# Living beyond our means



Earth Overshoot Day 2017  
lands on August 2.

By August 2, 2017, we will have used more from nature than our planet can renew in the whole year.

We use more ecological resources and services than nature can regenerate through overfishing, overharvesting forests, and emitting more carbon dioxide into the atmosphere than forests can sequester.

<http://www.overshootday.org/>

[www.scionresearch.com](http://www.scionresearch.com)

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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