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# Epichem OHD Presentation

21 April 2021



EQUITY  
PARTNERS



PharmAust  
LIMITED



# Epichem Pty Ltd

*Australia's premier provider  
of synthetic and organic chemistry services*

## Who are we

- Fully owned subsidiary of PharmAust Limited
- Australian-based Contract Research Organisation
- Based in Perth
- Top Australian SME employer of PhD graduates
- 18 years success helping clients worldwide
- National and State export award winner

## Experts in

- Synthetic, organic & medicinal chemistry
- Technical problem solving
- Analytical chemistry
- Material science
- IP generation & protection



**Our Formula. Your Success.**



## The Problem

Waste, waste, waste of finite resources into landfill

## The Current Solution

Costly, labour-intensive recycling

## The Smart Solution

Scalable, modular recycling supporting circular waste economy with OHD

# Policy Alignment & Government Incentives



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## 2020 federal budget

- ◆ \$250m injection over 4 years into waste & recycling initiatives

## 2019 national waste policy

- ◆ 10% reduction in waste generation per capita by 2030
- ◆ 80% average resource recovery rate from all waste streams
- ◆ Phase out problematic, unnecessary plastics by 2025

## West Australia's waste avoidance & resource recovery strategy for 2030

- ◆ Avoid, recover, protect
- ◆ 10% reduction in waste generation per capita by 2025
- ◆ 70% recovery of material by 2025

## Australia's biofuel production 30-year growth target

- ◆ Currently lagging biofuel production relative to global average, working to achieve 30-year target
- ◆ Launched new bioenergy road map for greener future

## Australian Government incentives for renewable energy

- ◆ Carbon credits, grants, financial assistance (ARENA<sup>1</sup>) (CEFC<sup>2</sup>)

## Corporate social responsibility goals

- ◆ Australia's big 4 banks have joined RE100 & announced commitment to 100% clean energy by 2025





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# Oxidative Hydrothermal Dissolution (OHD)

Novel, disruptive technology for converting organic feedstocks to high value products

# What is OHD?

A novel continuous, hydrothermal process to convert macromolecular organic solids into low molecular weight organic chemicals using only

- Elevated temperature [ $\pm 270$  C]
- High pressure [ $\pm 2500$  psi]
- Liquid water
- Molecular oxygen

# OHD

Oxidative Hydrothermal Dissolution  
Integrated Non-Catalytic Process

FOR

The production of fuels & high value chemicals

FROM

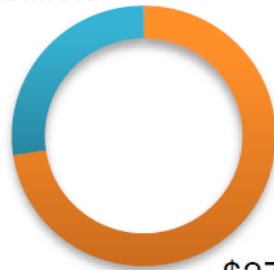
Macromolecular organic solids including biomass such as municipal waste, straw, plastic, tyres, oil shale & coal

# Global Market Opportunities

## BIOPLASTICS

**CAGR 21.7%**

\$10.5 billion



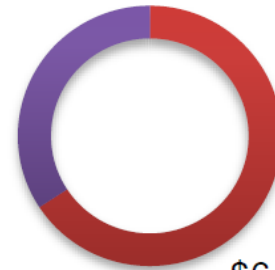
\$27.9 billion

- 5-Year Forecast
- Current Global Market

## BIOETHANOL

**CAGR 14%**

\$33.70 billion



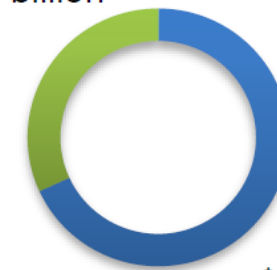
\$64.80 billion

- 5-Year Forecast
- Current Global Market

## BIOSTIMULANTS

**CAGR 12%**

\$2.50 billion



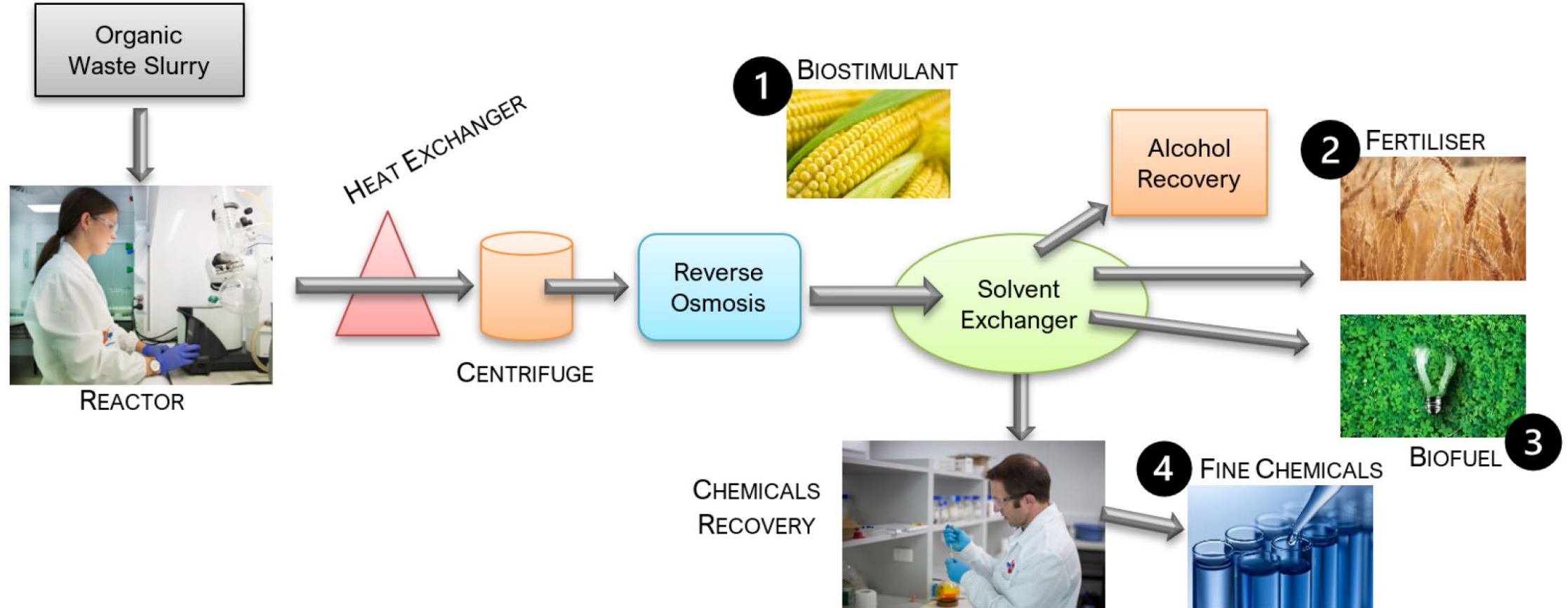
\$5.35 billion

- 4-Year Forecast
- Current Global Market

1 Source: Reportlinker – Bioplastics & Biopolymers Market by Type, End-Use Industry, Region - Global Forecast to 2025  
 2 Source: Reportlinker – Bioethanol Market by Feedstock, End-Use Industry, Fuel Blend and Region - Global Forecast to 2025  
 3 Source: Technavio – Global Biostimulants Market 2020-2024



# How Does Waste Generate Money?



≥ 4 revenue streams identified to-date including biostimulants production, fertiliser, biofuels, fine chemicals

# OHD Inputs & Outputs



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## Various Feedstocks

- ◆ Biomass FOGO (cellulosic & lignitic) & farm waste
- ◆ Plastic
- ◆ Tyres
- ◆ Oil shales
- ◆ Coal (all ranks)
- ◆ Organic-containing waste streams

## OHD Product Outputs

- ◆ Platform chemicals
- ◆ Liquid fuels including drop in fuels
- ◆ Agricultural biostimulants



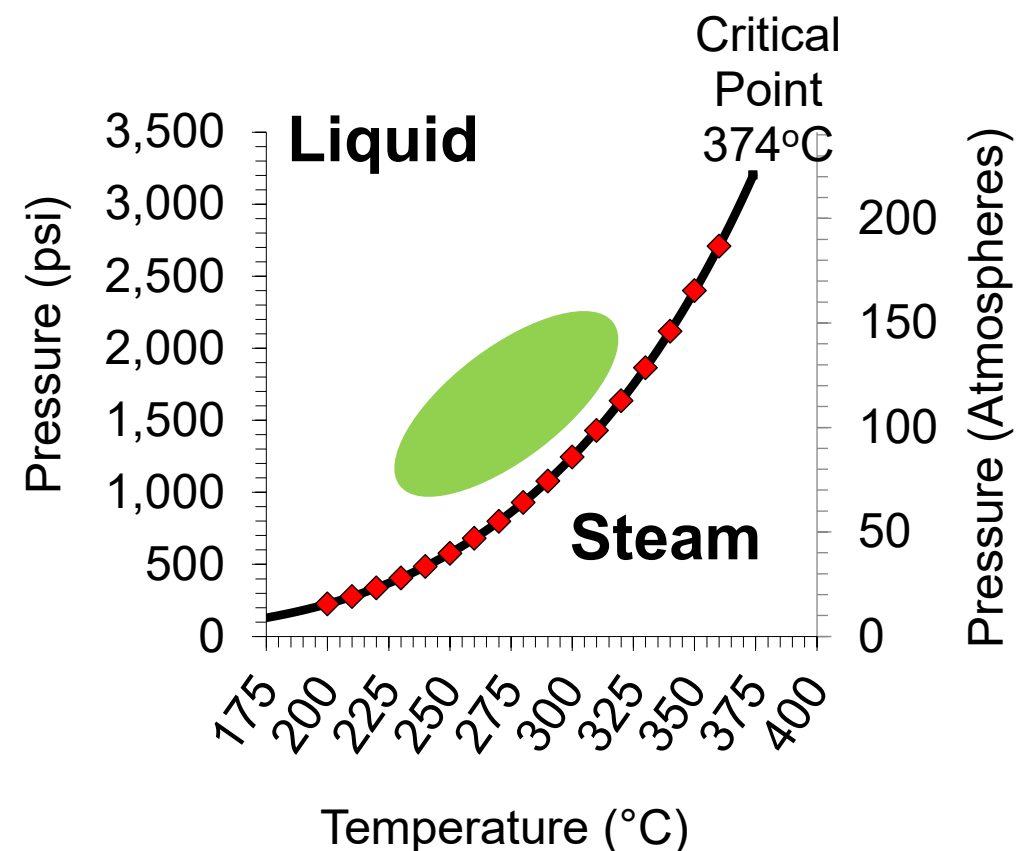
# OHD Process Advantages

- ◆ Technically straightforward & operates at industrially feasible conditions & rates
- ◆ Uses only water & oxygen, requires no exotic solvents or catalysts
- ◆ Readily achieves high to complete conversion of the starting solid with high recovery (typically 70-90+% C) of the products
- ◆ Inherently environmentally friendly
- ◆ Produces little CO<sub>2</sub>
- ◆ Minor gaseous product is mainly CO<sub>2</sub>
- ◆ No NO<sub>x</sub> or SO<sub>x</sub> or other problematic emissions



# OHD Process Overview

- ◆ OHD converts macromolecular organic solids into low molecular weight, water soluble products by a direct process based on oxidative bond scission
  
- ◆ OHD works by reaction of macromolecular organic solids with dissolved oxygen, in superheated water (ie 200-370°C)
  
- ◆ The high pressure maintains the water as liquid
  
- ◆ Feedstocks include anything carbon-based such as
  - Biomass, coal, oil shale, bituminous sands, plastic, rubber, agricultural waste etc





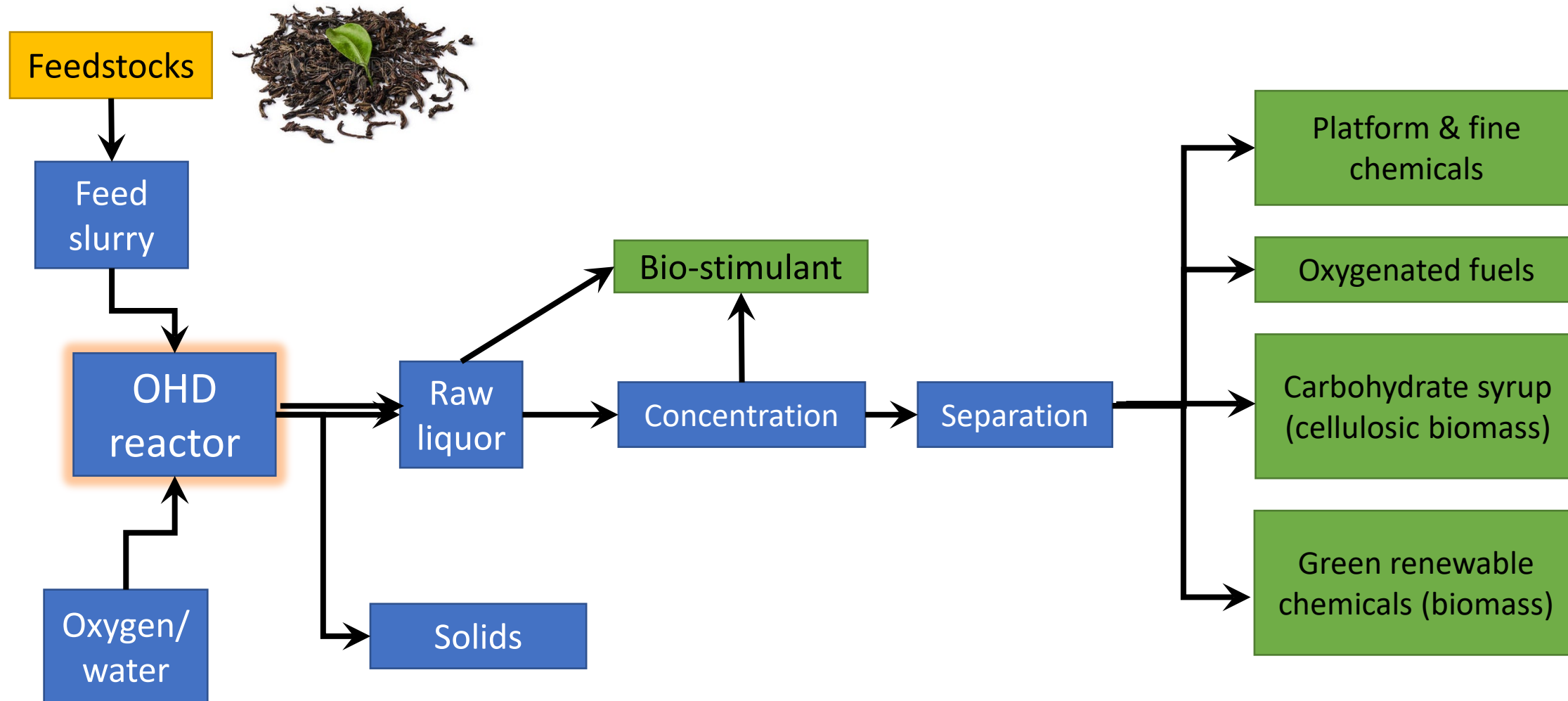
# OHD Flow Reactor Conversion Potential

- ◆ Plastics into renewable fuels
- ◆ Coal into diesel or agricultural biostimulants
- ◆ Rubber tyres into liquid fuels/valuable chemical products
- ◆ Trees into cellulosic ethanol &/or fine chemicals
- ◆ Leftover stock or crops into liquid fuel, cellulosic ethanol & agricultural biostimulants



Scaled up OHD flow reactor designed by Australian scientist Ken Anderson, currently operating in Illinois State University USA

# Feedstock Processing by OHD





# Biomass OHD Feedstocks & Products

## Feedstocks

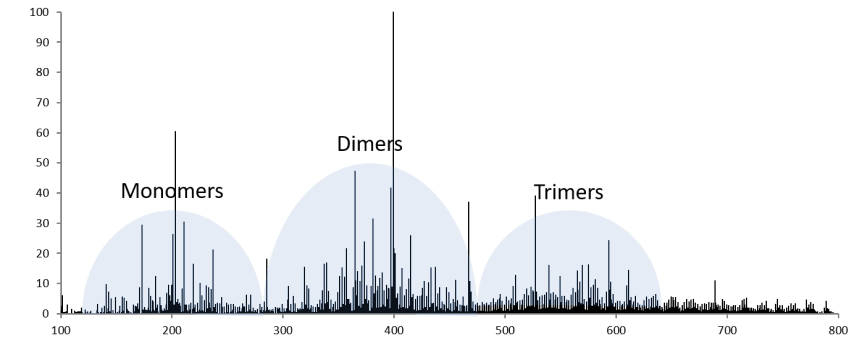
- Wood & energy crops
- Agricultural wastes (wheat, canola & other straw, bagasse, corn stover etc)
- Municipal waste (carboard, paper, green, food & cotton-based textile wastes)
- Other waste streams

## Cellulose derived sugars (OHD syrup)

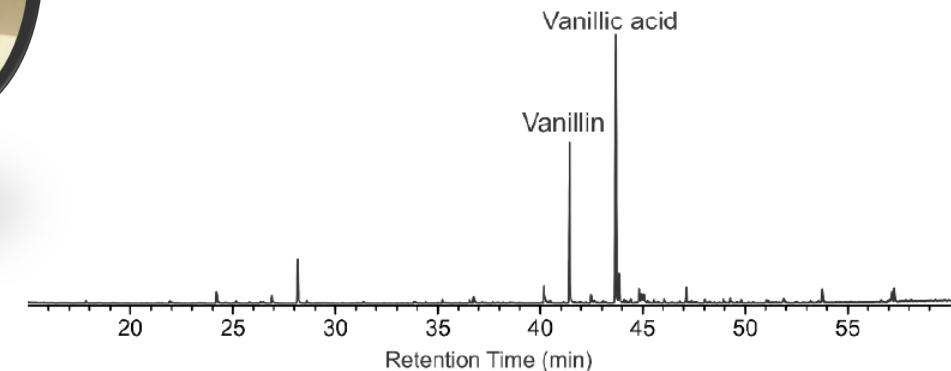
- Fermentation to bio ethanol (cellulosic ethanol)
- Anaerobic fermentative hydrogen production (bio hydrogen)
- Food source for microbes or insects (biorefinery)

## Lignin derived products

- Platform chemicals
  - Green & biodegradable plastics & polymers
- Green renewable fine chemicals
- Agricultural bio-stimulant



**Raw OHD product of lignocellulosic biomass (pine)**



**Distribution of products generated by OHD of softwood lignin**

# Non-Biomass OHD Feedstocks & Products



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## Feedstocks

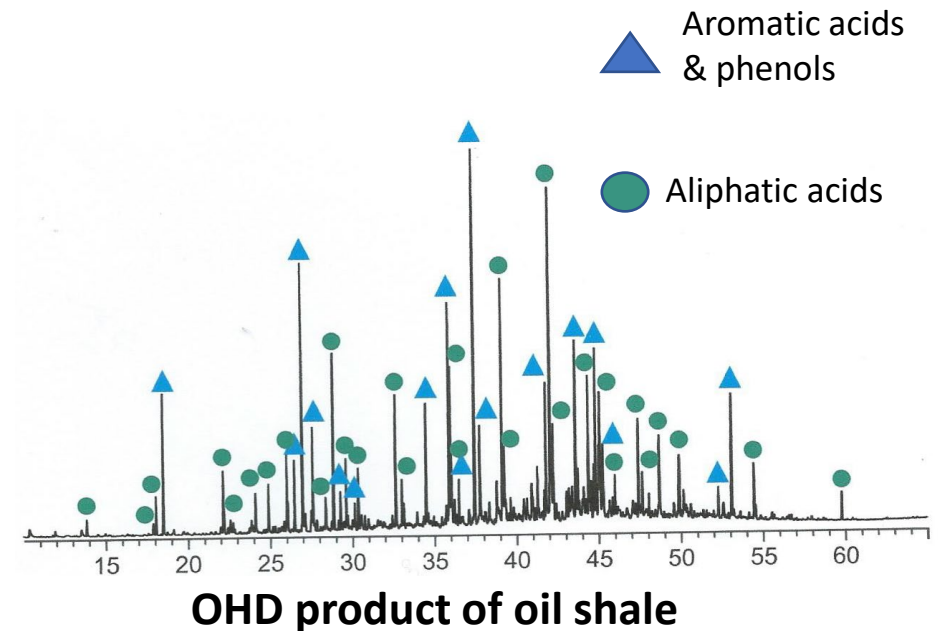
- ◆ Coal (all ranks), oil shale, bituminous sands
- ◆ Plastics, polymers, synthetic wastes
- ◆ Many other waste streams

## Products

- ◆ Platform & fine chemicals
- ◆ Bio-stimulant (raw OHD liquor from brown coal)
- ◆ Liquid fuels

## Potentials

- ◆ “Upgrading” (eg by hydrogenation) to higher energy liquid fuels
- ◆ Synergy with existing synthetic fuel & related technologies



# OHD Products

## Platform Chemicals & Carbohydrates



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- ◆ Platform chemicals act as building blocks for conversion to high value chemicals or materials
- ◆ Products derived from celluloses can be fermented & converted to drop in fuels
- ◆ Organic acids derived from processing plastics make excellent platform chemicals
- ◆ Raw mixture from some feedstocks has potential to be an effective, climactically suited agricultural biostimulant



# Our Experience in Hydrometallurgy



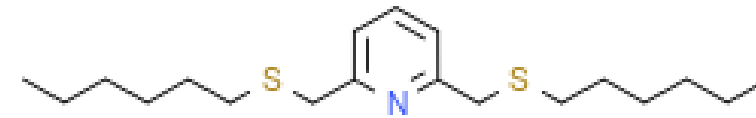
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## Custom synthesis

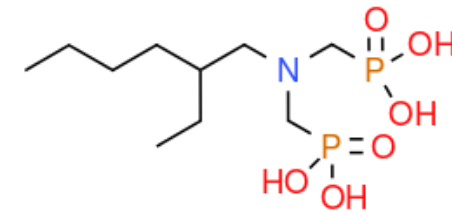
- ◆ Extractants & collectors
- ◆ Ligands & chelators
- ◆ Impurities, standards & authentic samples

## Analysis & problem solving

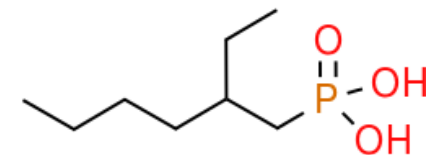
- ◆ Experts in organics chemistry
- ◆ Sample testing & quality control of organics
- ◆ Degradation studies
- ◆ Comprehensive analytical capability
- ◆ GCMS, LCMS, HPLC, NMR, ICP, IR, Karl-Fischer, XRD & more



Rhodium Extractant



Flotation collector + Corrosion inhibitor



Rare earth extractant (P507) degradant

# Oxidative Hydrothermal Mineral Extraction

Can OHD be used for innovation in minerals processing?



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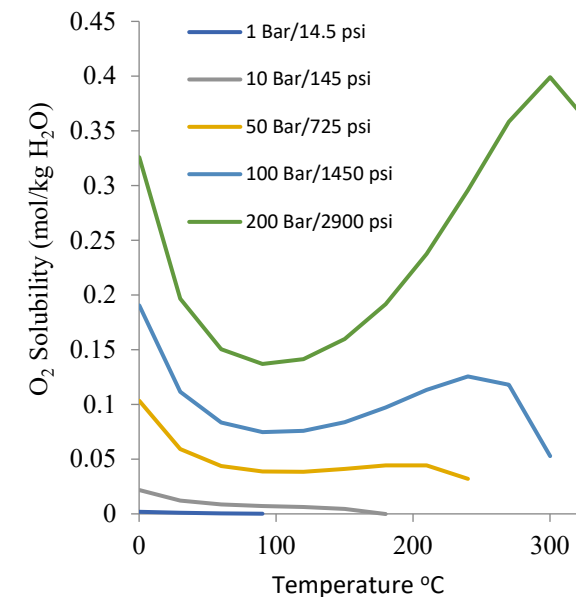
OHD-related mineral extraction concepts to be explored:

- Direct leaching & extraction of mineral ores
- Pre-treatment of refractory ores
- Other recovery or refining processes

Related to high pressure oxidation (HiPOX) & pressure leaching

How does the absence of a gas phase affect oxidative process of minerals?

Oxygen Solubility in Water vs Temperature



# OHD Highlights



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**Capitalising on policies at national, state & local government levels towards zero organic waste to landfill**

## Proof of Concept

- Coal
- Lignocellulosic biomass (ie plant matter)

## External Outcomes

- Removal of organic waste
- Conversion of organic waste to valuable end-user products, fine chemicals & critical metals
- Reduce landfill
- Convert liabilities into assets

## Internal Outcomes

- Validation of inorganic processing
- E-waste conversion
- IP generation/patent protection
- Very broad biomass/feedstock license field
- Territory includes Australia, New Zealand, Singapore, Hong Kong, South Korea & Taiwan

Chemistry expertise in collaboration & partnership with energy, agriculture, mining, oil & gas & waste sectors



ENERGY SECTOR



AGRICULTURE SECTOR



TEXTILES SECTOR



WASTE SECTOR



MINING SECTOR



BIOTECHNOLOGY SECTOR



# Epichem 2021 Highlights



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## DNDi Contract Extension

- Secured for 13<sup>th</sup> consecutive year
- Contract has delivered AU\$15m+ revenue
- 500 compounds delivered in 2020

## Oxidative Hydrothermal Dissolution (OHD) Technology

- Extension of material science chemistry expertise
- Conversion of biomass & feedstock into useful end products & recovering valuable & critical metals
- Direct sub licence agreement

## WasteSorted e-Waste Grant

- AU\$200,000 from WA Government New Industries Fund
- OHD technology research & development
- Benchtop flow reactor build

## Australian Export & Investment Awards 2020

- Only WA recipient awarded
- 360 nominations nationally
- Spirit & remarkable resilience in the face of challenge
- Channel 7 Feature (air date TBC)
- Austrade interview, video & website feature



# Our Awards

- 2020** Austrade Award WA Nomination Winner - resilience, ingenuity & courage of Australian exporters
- 2020** GHP Biotechnology Most Innovative Australian Chemistry Service Provider & Best in Organic Chemistry Solutions
- 2019** Epichem wins International Health Award at the WA Industry and Export Awards
- 2019** Chief Scientific Officer Dr Martine Keenan awarded Fellowship to the Royal Society of Chemistry, UK
- 2018** ISO 17025 & ISO 17034 accreditation
- 2017** WA Exporter of the Year Award & Health & Biotechnology Award, WA Industry & Export Awards



Government of **Western Australia**  
Department of **Jobs, Tourism, Science and Innovation**

# WINNER

**International Health**





# Questions?



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