Envisioning the use of CO_2

- Progress from a Latrobe Valley perspective

Assoc. Prof. Vince Verheyen

ENVISIONING THE USE OF CO_2

ANY LARGE SCALE CO_2 RESOURCE WILL NEED:

- CAPTURE AND CONVERSION
- REUSE OPTIONS

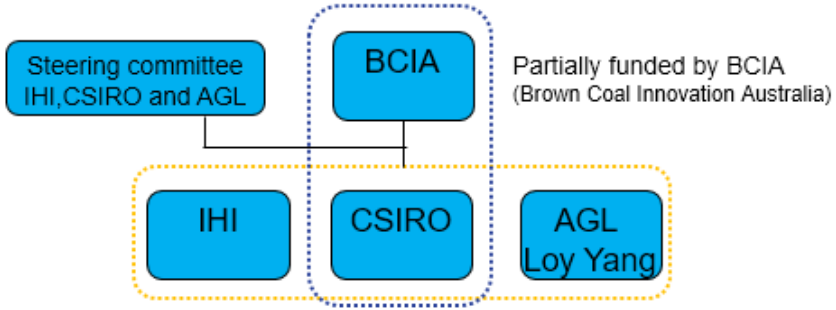
NEED FOR TRANSFERABLE KNOWLEDGE FROM POWER TO OTHER OPERATIONS

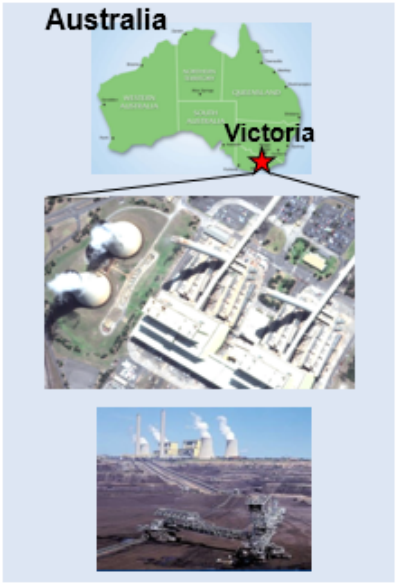
THE VALLEY'S LARGE & DIVERSE CARBON RESOURCES REQUIRE A FOCUS ON NICHE CO_2 APPLICATIONS AND INNOVATION THAT ARE A FIT FOR THIS REGION

Current Local CO_2 Capture R&D

PICA project

PICA (Post-combustion carbon capture, IHI, CSIRO, AGL)





Loy Yang A Power Station & Loy Yang coal mine

IHI Corporation

- Design, construction, operation and evaluation of the PCC pilot plant (IHI system)

AGL Loy Yang Pty Ltd

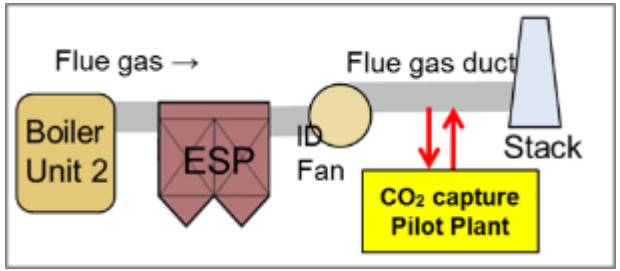
- Operator of Loy Yang A Power Station using brown coal
- Host of PCC pilot plant in this power plant.

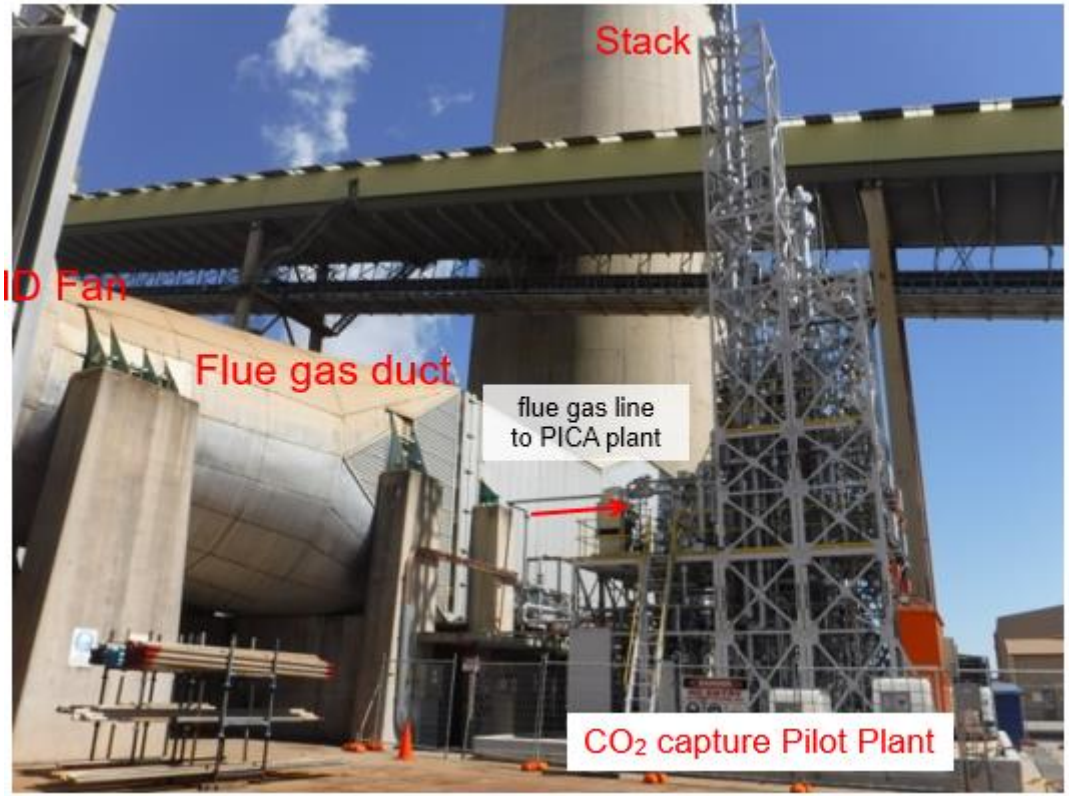
CSIRO (the Commonwealth Scientific and Industrial Research Organisation)

- Supporting design, site preparation, operation and evaluation of the pilot plant.

Current Local CO_2 Capture R&D

PICA Pilot Plant @ Loy Yang A



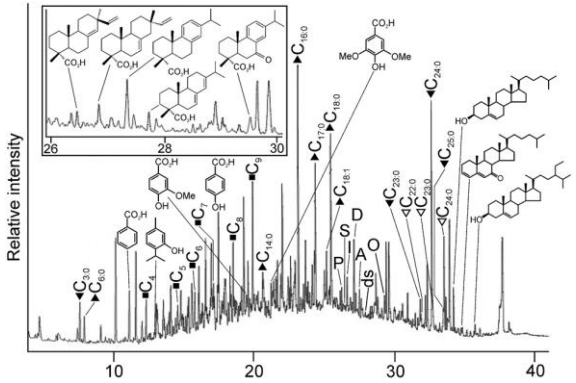


ENVISIONING THE USE OF CO_2

POWER INDUSTRY ACTS AS AN ENABLER

DEVELOPING TRANSFERABLE KNOWLEDGE ON CAPTURE TECHNOLOGY THAT'S APPLICABLE TO OTHER VALLEY OPERATIONS

CCS RESEARCH LABORATORY



Tracking molecules to understand:

1. **CO_2 capture system degradation**
2. **Turning carbon into products**

ENVISIONING THE USE OF CO_2

ANY LARGE SCALE CO_2 RESOURCE WILL NEED:

- **REUSE OPTIONS**

MIMICKING & WORKING WITH NATURE

THE VALLEY'S LARGE & DIVERSE CARBON RESOURCES REQUIRE A FOCUS ON NICHE CO_2 APPLICATIONS AND INNOVATION THAT ARE A FIT FOR THIS REGION

Evaluating innovative local CO_2 utilisation opportunities

Typical CO_2 utilisation/conversion routes

- **Photo/thermo/electro catalytic**
- **Energy intensive and expensive**

Taking cue from nature for CO_2 conversion into products

- **We are designing a biorefinery concept that mimics nature and generates products from CO_2 and bio-wastes**

<u>Non-food/waste</u> resources in the Valley

- **Trees, forest/wood waste**
- **Horticulture, agriculture/waste**
- **Dairy, abattoir**
- **Municipal / Industrial wastes**

CO_2 Utilisation in our Biorefinery Concept

Drivers: "Carbon Negative", Multiple Products and "Zero Waste"

Step 1: Using Supercritical CO_2 for Extraction

- **Vitamins, fatty acids, oils, food flavours, waxes, fragrances**

Step 2: Chemical Production

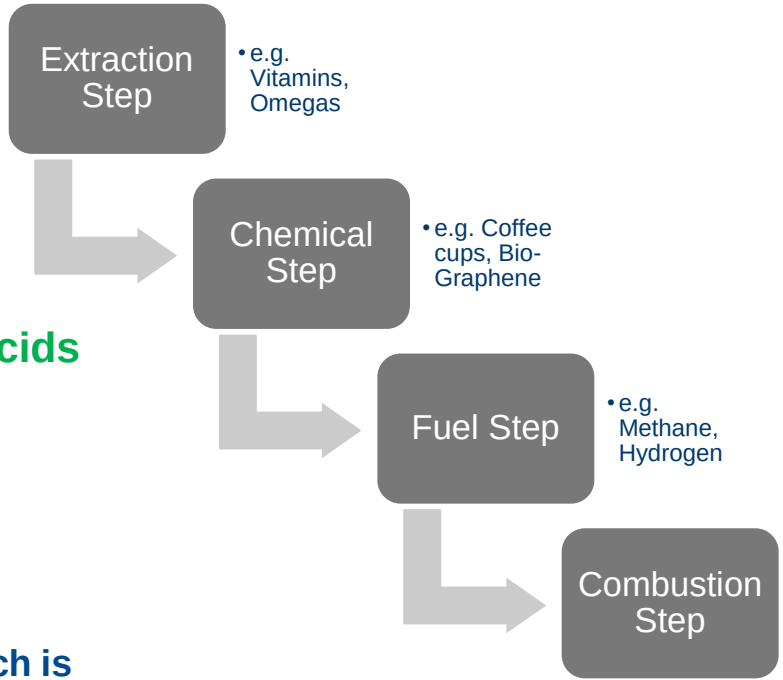
- **Microbes convert CO_2+Biomass into acetic & succinic acids**

Step 3: Fuel Production

- **Leftover biomass is converted into methane**

Step 4: Combustion/Pyrolysis/Gasification

- **Methane production leaves some undigested biomass which is converted into electricity & biochar**



Biodegradable Plastics from Succinic Acid

Incorporate CO_2 into biodegradable plastics

- **Coffee Cups, grocery/garbage bags, packaging and a range of other plastic products**
- **Insulation tiles in construction**

> **CO_2 lock-in for decades**

Plastic Waste is a Big Problem

Bio-Degradable Plastic is a Solution

Only degrades once buried in soil

- **Converts into CO_2 and H_2O**

Bio-Degradable Plastic Products

Bio-Degradable Coffee Cup

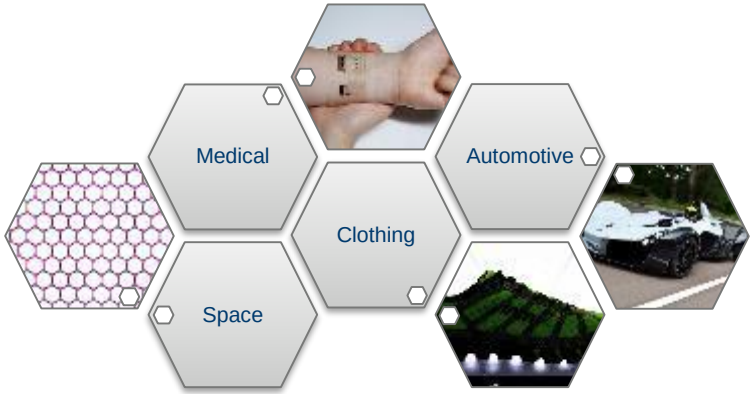
Or back to the biorefinery for recycling

- **This locks-in CO_2 in a continuous cycle**

Hi-Tech Products from Acetic Acid

Bio-Graphene

- Use CO_2 to convert Acetic Acid into a chemical precursor for Bio-Graphene



Transparent Bio-Plastic from Acetic Acid

- Solar panels, greenhouses, bio-medical, 3D-printing

Bio-Fuels from Acetic Acid

- Dimethyl Ether
- Ethanol

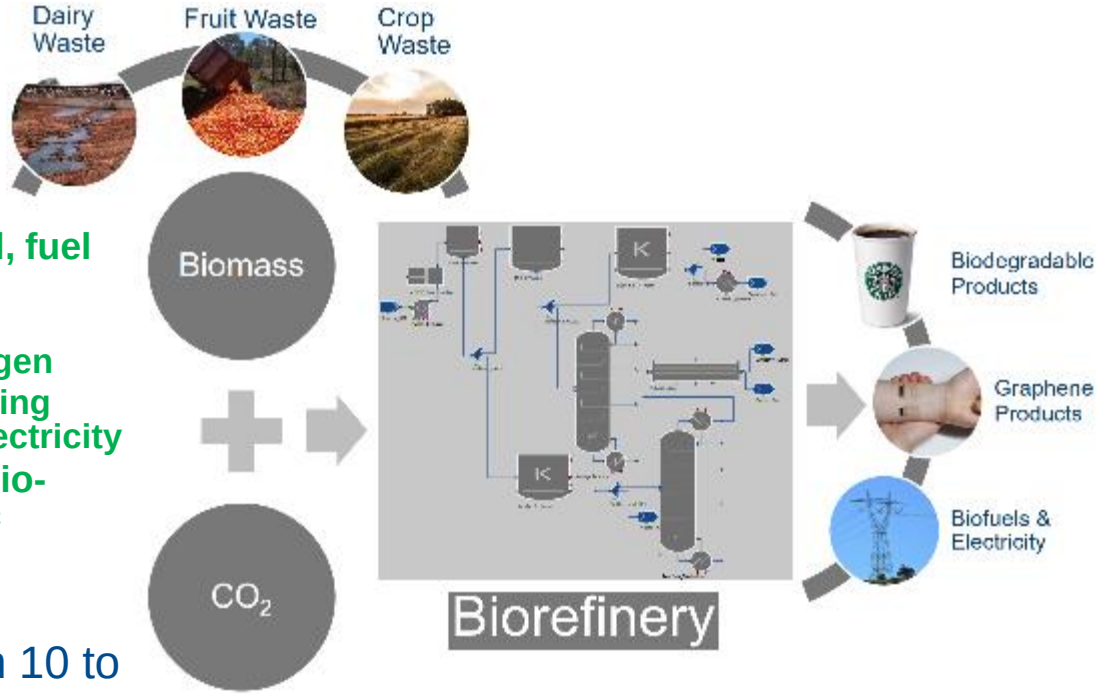
Biorefinery Simulation Results

3500 tonnes of biomass produces

- 950t succinic acid
  - **Biodegradable products**
- 420t acetic acid
  - **Integrate with electrolytic cell, fuel cell, metal hydride hydrogen storage to produce**
    - > **200t ethanol + 8.5t Hydrogen**
    - > **Hydrogen is produced using 1700MWh surplus grid electricity**
  - **OR convert acetic acid into Bio-Graphene/transparent plastic**
- 1500t CO_2 removed from atmosphere

Model suitable for feedstock size from 10 to 3500 tonnes per day

Competing models also investigated



ENVISIONING THE USE OF CO_2

APPLICATIONS AND INNOVATION THAT ARE A FIT FOR THIS REGION

MINIATURISATION DRIVING MOBILITY

Mobile Biorefinery

Transporting Gippsland Biomass/Wastes is expensive! Take the biorefinery to the source

Mobile and Modular (~5 semi trailers)

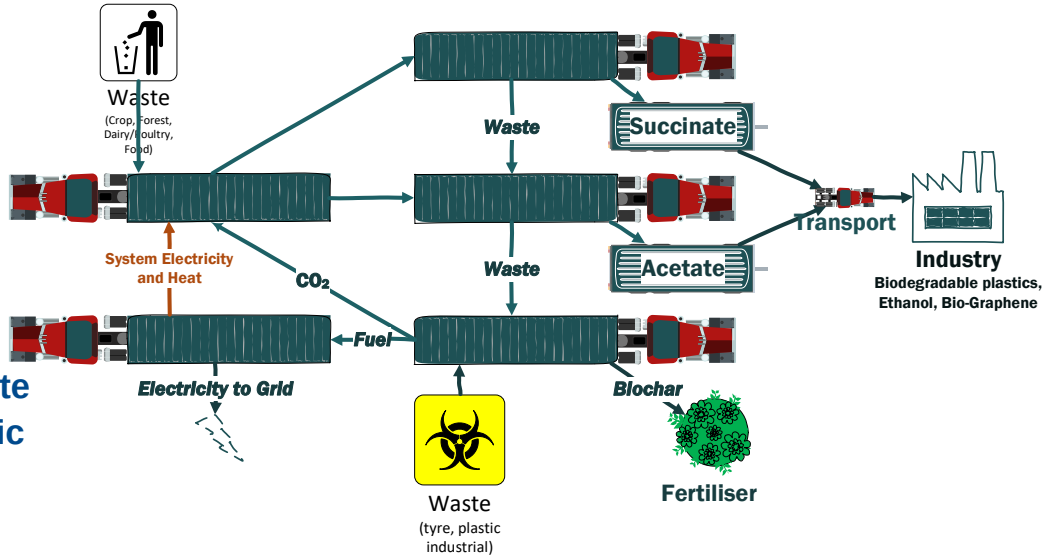
- Extract oils, pigments, vitamins,
- Convert biomass into value added chemicals and animal feed
- Generate onsite electricity from leftovers
- Leave biochar to improve soil

Feedstock

- Dairy, horticulture, wood/forest waste
- Also suitable for tyres, plastics, toxic wastes

Outcomes

- Advanced engineering / design
- High value niche manufacturing



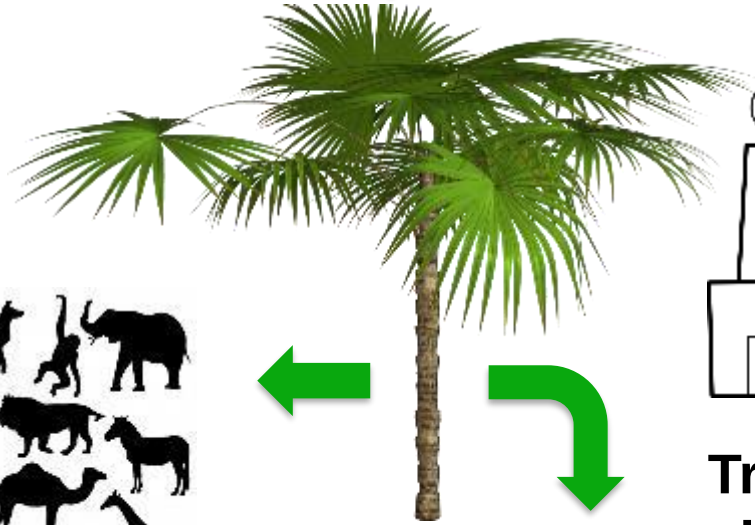
Carbon Technology Research Centre (CTRC)

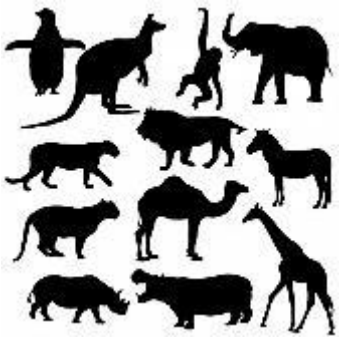
Federation University Australia

PRE MANKIND

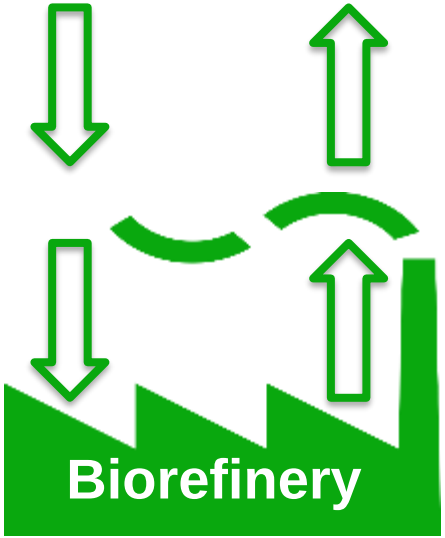
INDUSTRIALISATION

SUSTAINABLE MANUFACTURING





Traditional industry



cyclic

one way

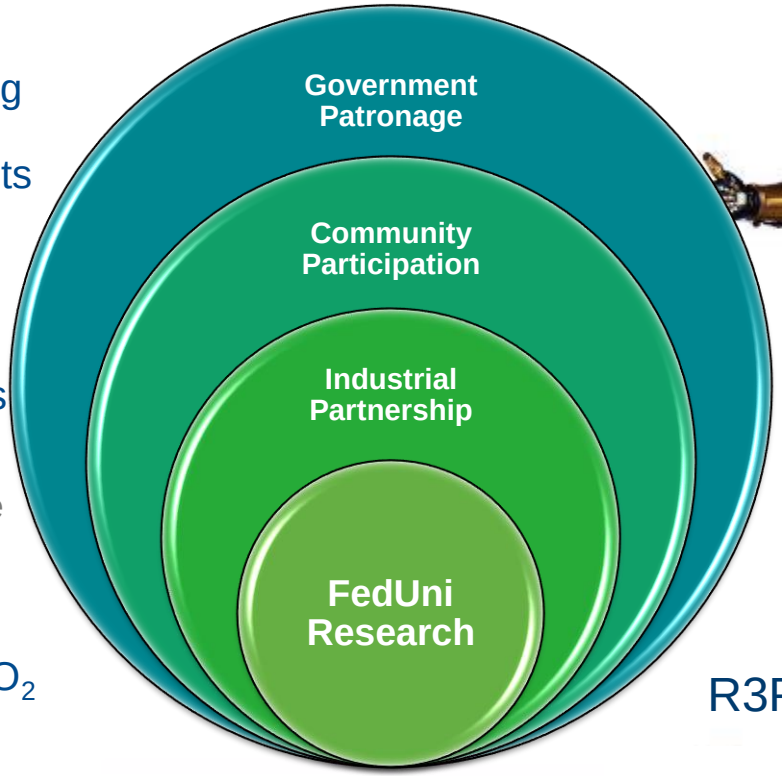
cyclic

Towards Bio-refining in our Region

Research, **P**artnership, **P**articipation, **P**atronage **O**rder (**R3PO**) framework guiding biorefinery research from Lab to Industry

- Fulfilling local industry requirements
  - E.g. dairy, wood, horticulture
- Capitalising on local resources
  - Power industry human resource
  - Electricity grid, peaking stations
- B2B coordination for final products
  - E.g. bio-degradable grocery bags, coffee-cups, solar panel coats, greenhouses, defence, aerospace
- Creating transferrable knowledge and products for other areas

A unique win-win situation: job creation, biodegradable plastic/power generation, CO_2 emissions reduction



R3PO Framework

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ANLEC R&D
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