



Ricardo  
Energy & Environment

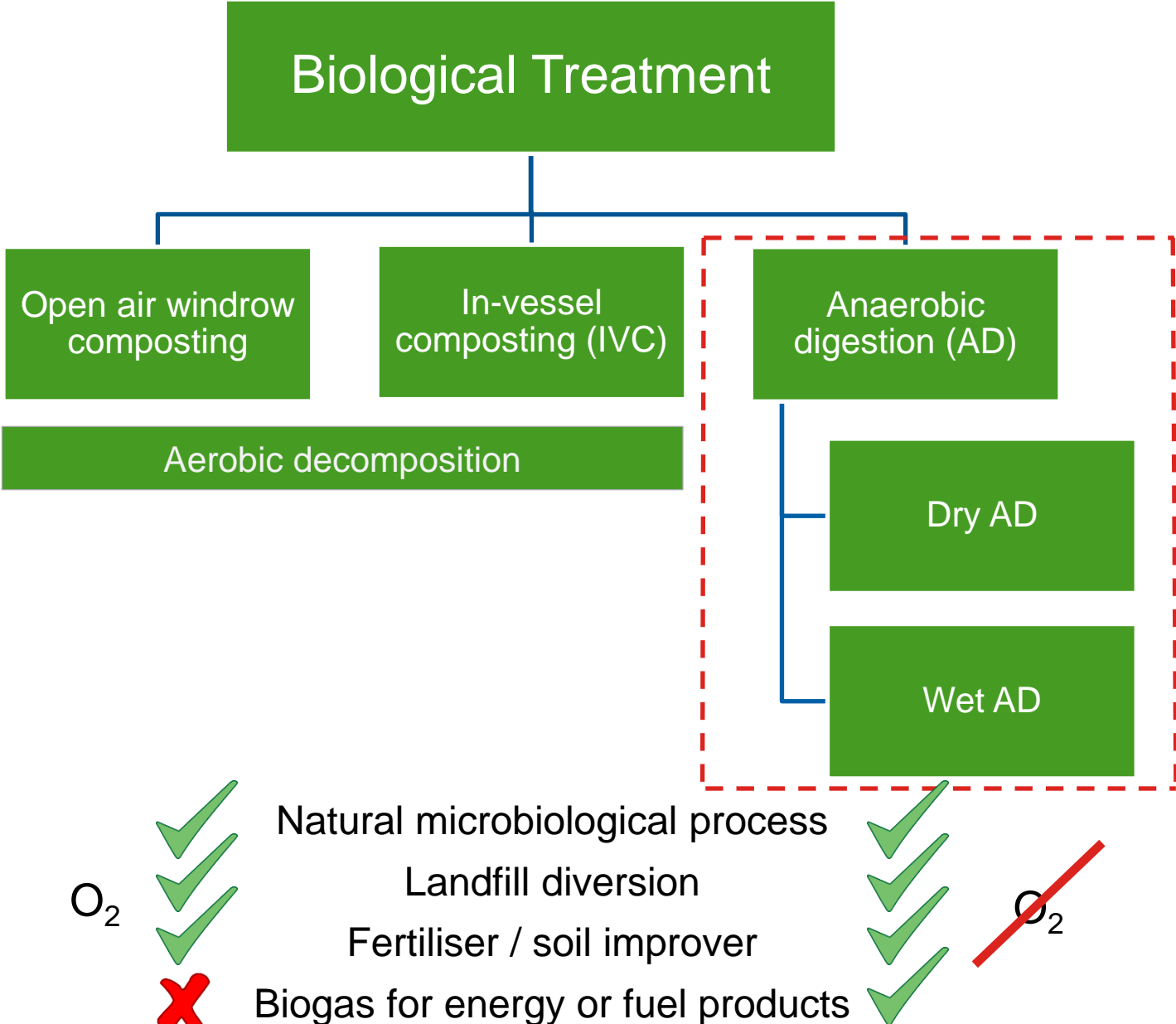
Biological Treatment  
Phil White MCIWM



# Biological Treatment – Feedstock

- Readily biodegradable
  - Garden and parks waste
  - Household food waste from households
  - Commercial food waste, including packaged
    - Past shelf life food
    - Hospitality and catering waste
  - Industrial waste
    - Food and drink manufacturing waste (e.g. brewery, dairy, bakery waste)
  - Agricultural wastes
    - Crop residues (energy crops)
    - Animal slurry, rendering waste
  - Sewage sludge
- Different pre-treatment requirements
- Different gas yields
- Source separated or screened residual organics





# Biological Treatment – Aerobic Composting

- **Open Air Windrow Composting (OAWC)**

- Simple, proven, understood
- Low Capex / Opex, low risk
- Compost for use as soil improver
- Food waste / animal by-products
- Bioaerosols, potential odour
- Favours rural location
- Net energy user
- Significant land take



- **In-Vessel Composting (IVC)**

- Initial ('sanitisation') stage in enclosed vessel
- Subsequent open air windrow composting
- Similar OAWC – higher Capex / Opex
- Co-treat food waste / animal by-products
- Faster processing
- Better emission control (biofilter)
- Similar OAWC – higher energy use



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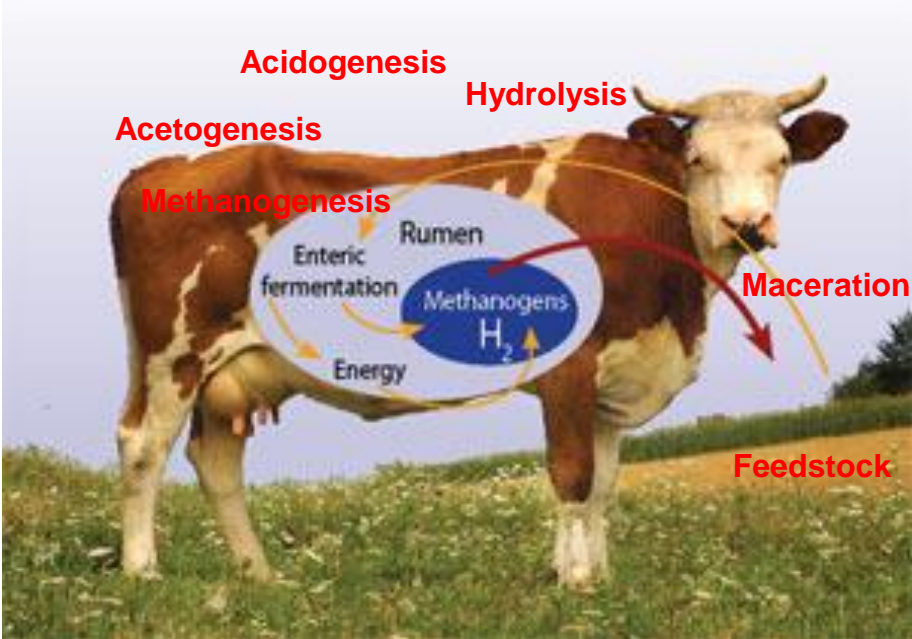
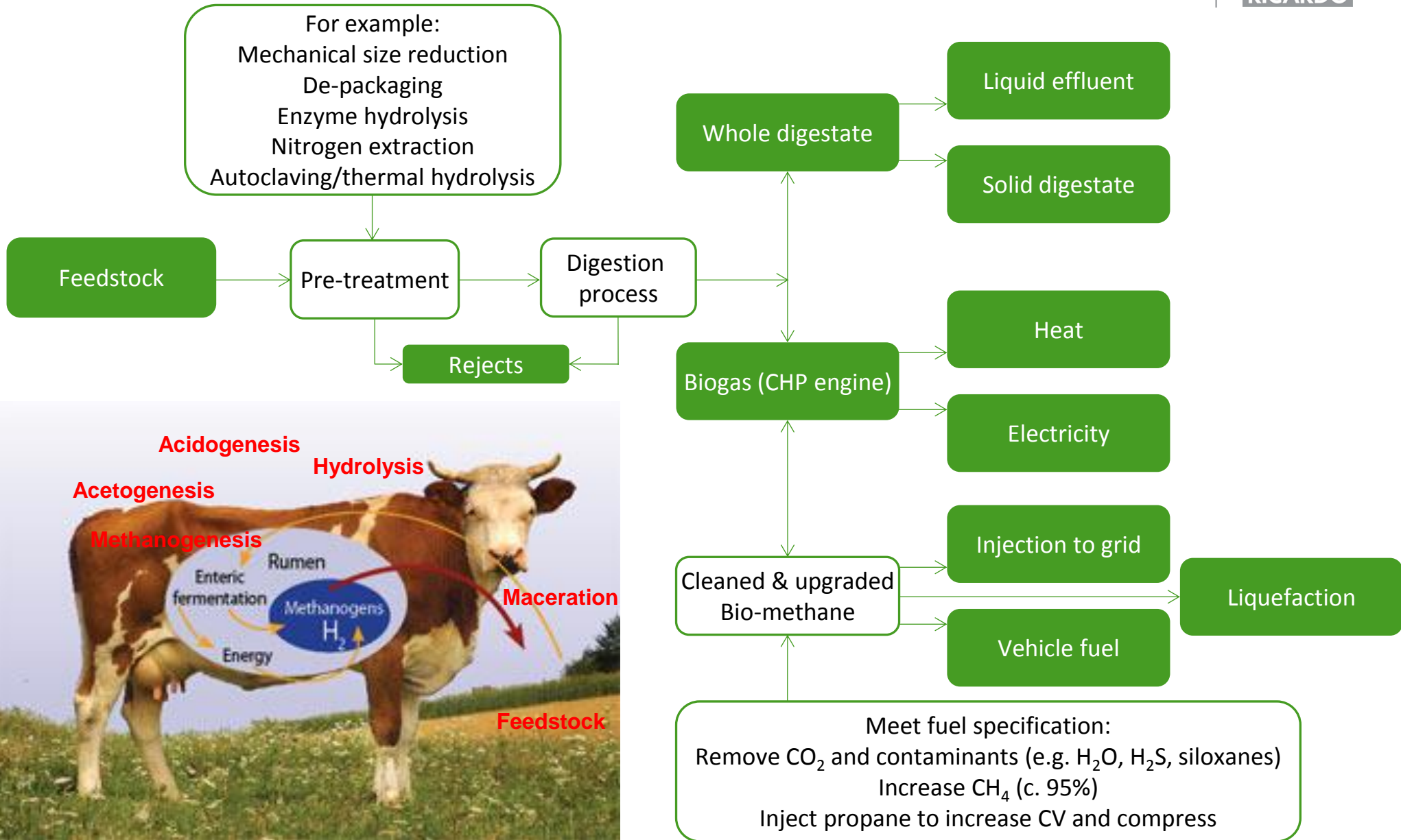
# Biological Treatment: Anaerobic Digestion (AD)

- Natural process
  - Micro-organisms digest organic matter in the absence of oxygen
  - Established 100 years in water sector – understood
- Generates biogas (c. 60% methane, 40% CO<sub>2</sub>)
  - Renewable energy
  - Electricity & heat generation, fuels
  - Volume depends on biomethane potential of waste
- Controlled, accelerated process that occurs in landfill



Wet AD systems	Dry AD systems
<10% dry solids	Higher dry solid content 15-40%
Maceration and mixing required	Less mechanical treatment
Typically food waste, manure, slurry	Typically green waste, co-collected food and green waste, energy crops
Water addition or thickening for low solids	No water addition
Environmental constraints less onerous than dry AD	Environmental constraints more stringent, especially if combined with AOWC

# Biological Treatment – AD Process



# Biological Treatment: Wet AD

- Most common AD variant – track record
- Water added to food waste to create slurry
- Tanks – process variants e.g.:
  - By temperature, by scale, by mixing method...
- Low solids ‘whole’ digestate or dewater (liquor / fibre fractions)



- Energy revenue
- Proven, understood
- Flexible, low footprint
- Potential urban setting

Single stage process	Multistage process
Single reactor	Two or more reactors to optimise process
Simple economical design	Better process control & built-in redundancy
Produces less biogas	More biogas (depends on retention time & feedstock)
Lower Capex	Higher Capex (balance against flexibility and gas yield)

High digestate volume (85-100% input) – risk often overlooked

Digestate storage capacity & effluent treatment

**X** No green waste – source separated collection

Contamination – downtime (e.g. plastics and grit)

Some energy required to heat tanks





# Wet AD – Tekniska verken i Linköping (TVAB) Sweden

Opened 1996

Capacity 100,000 tonnes per annum

Feedstock 50:50 mix farm manures and organic waste

Biogas is upgraded to vehicle fuels

Operates 12 filling stations and 3 bus filling stations

Whole digestate to farmers (cost neutral)

Mesophilic



# Biological Treatment: Dry AD (High Solids AD)

- Waste stream 15-40% total solids – up to 50%
- Physical characteristics requires different approach to handling, mixed and pre-treatment
  - Pre-treated (screened) to remove physical contaminants
  - Inputs handled using conveyor belts, screws, walking floors and powerful pumps
  - ‘Tunnels’ or vertical vessels (not tanks)
- Normally higher temperature (thermophilic) – faster microbial process for higher organic load
- The biogas and digestate dealt with as for wet AD systems

Energy revenue

Tolerates higher contamination (lower technical risk)

Accepts green waste (co-mixed food) – suits less mature collection schemes

Proven (less common)

Composting back end – land take and emissions (although composting hall can be enclosed)

Favours rural location (if open air compost maturation)



# Wet and Dry AD – Advantages and Disadvantages

