

Six AD Pieces

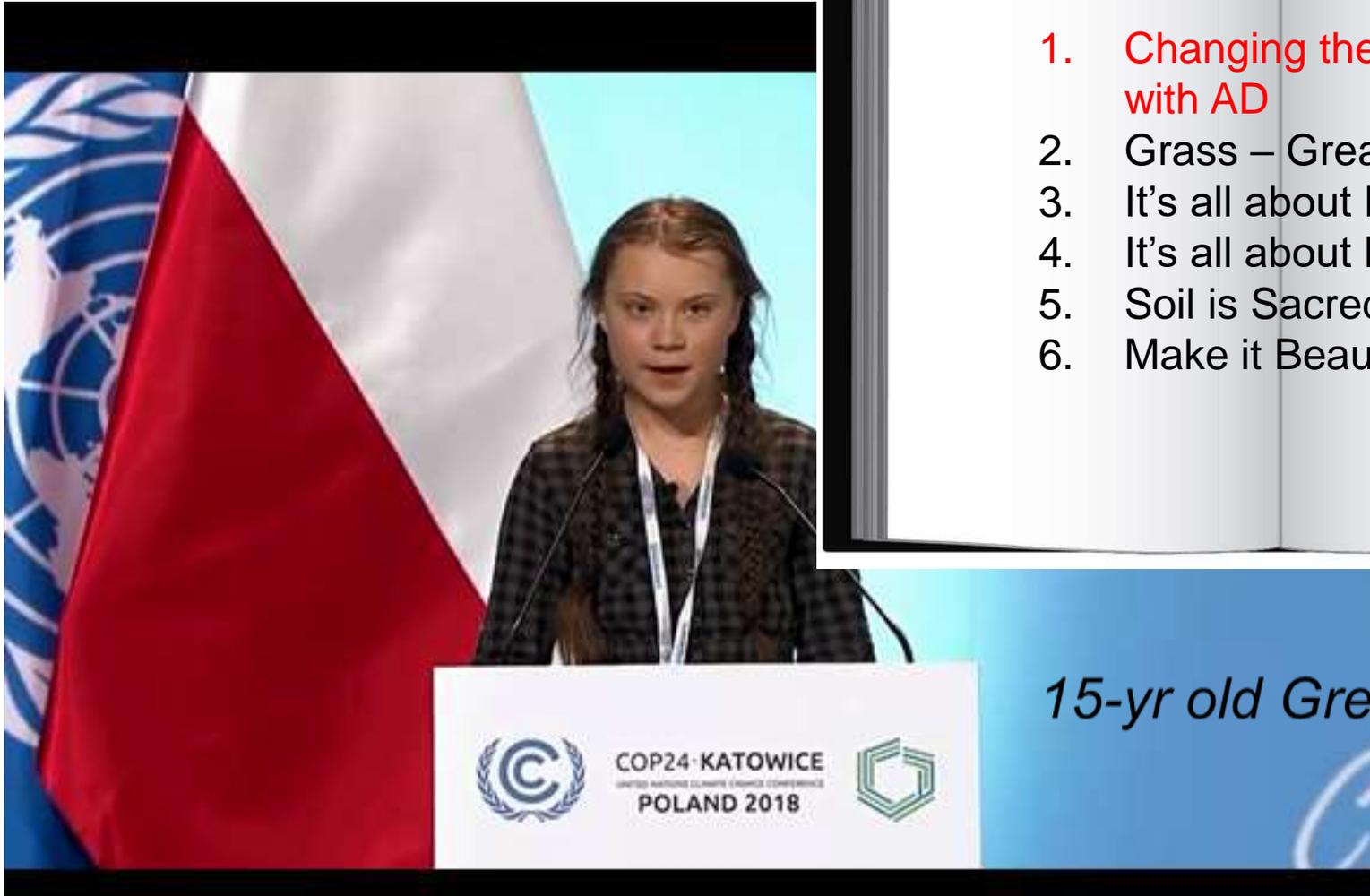
Dr. Les Gornall

ADNET Session 3 Alternatives and Complements to Methane as
AD products January 25th 2019



a PM Group company

Six AD Pieces



1. Changing the Climate with AD
2. Grass – Great but Greasy
3. It's all about Feedstock
4. It's all about Microbiology
5. Soil is Sacred
6. Make it Beautiful

15-yr old Greta Thunberg

“Until you start focusing on what needs to be done rather than what is politically possible, there is no hope.

We cannot solve a crisis without treating it as a crisis.

We need to keep the fossil fuels in the ground, and we need to focus on equity.” **15-yr old Greta Thunberg**



- *COP24 - 1.5 Degrees anthropomorphic global temperature rise should be **the upper limit** and to do this:*
- ***We need to: stop eating beef immediately (cows are sacred?)***
- ***dramatically reduce CO₂ emissions in 12 years***



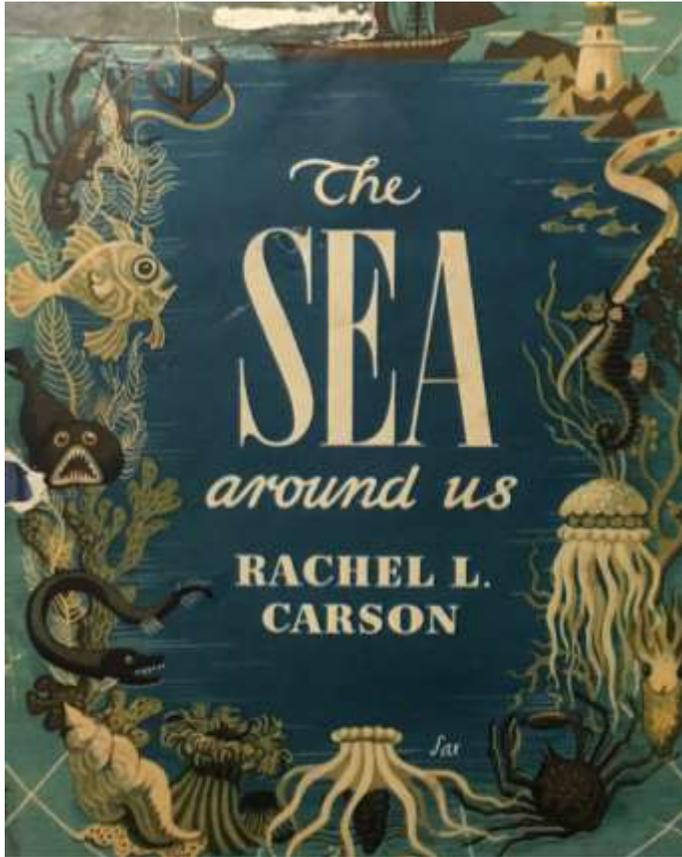
Changing the Climate with AD

Sea Level Rising is taken seriously in Lochmaddy – Outer Hebrides



light installation by Pekka

Changing the Climate with AD



1950

Rachel Carson observes that everything is connected to everything including global warming and the ocean / weather system

We have known about the issue of global warming and its consequences for 69 yrs.

Changing the Climate with AD



My friends Peter and Anne (Jan 2019)

Living close to the sea on Uist

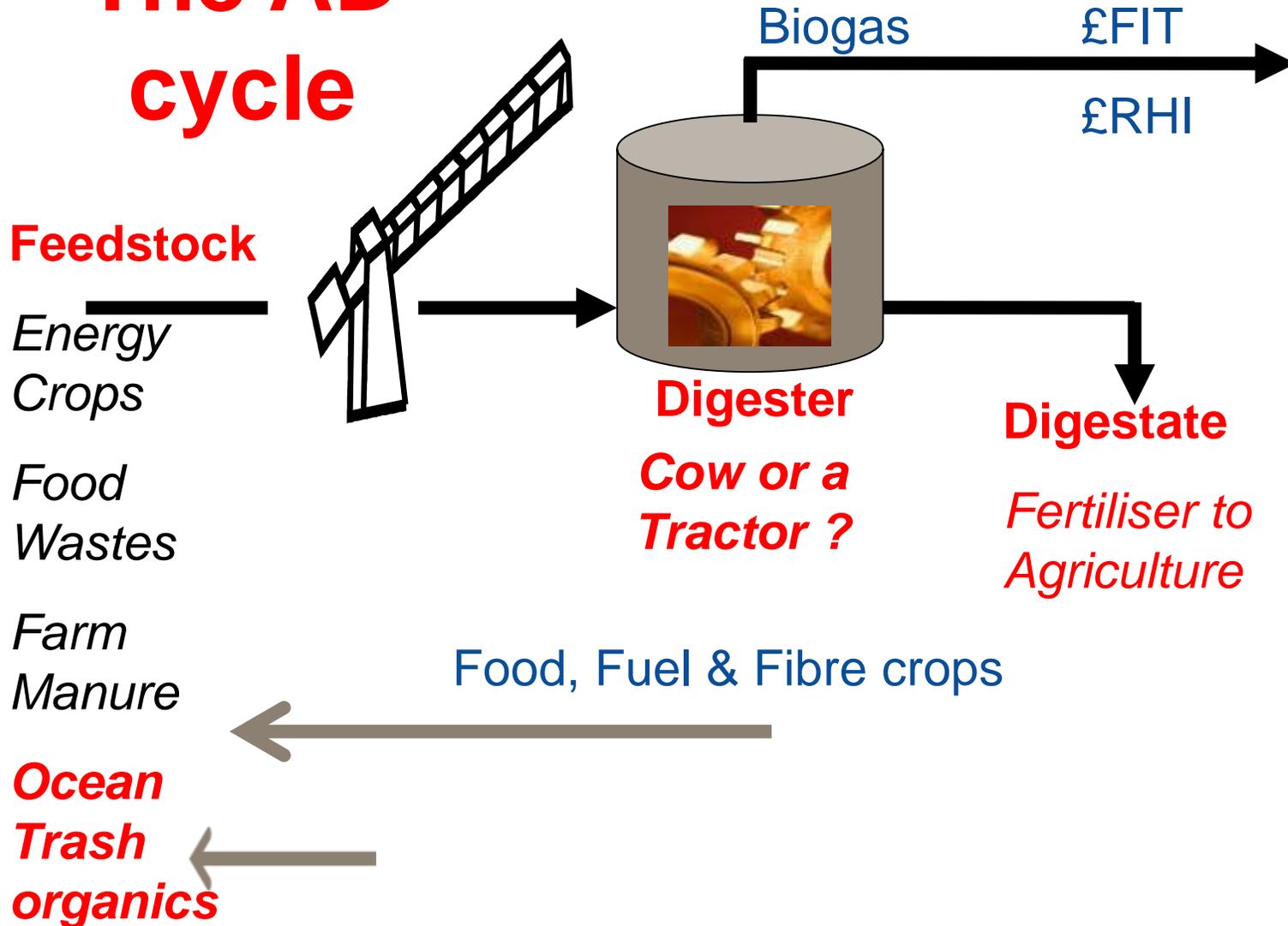
If they are flooded by rising sea levels
will we also loose London, Carlisle, and
most of our coastal cities?

A family of 5 people drowned here
escaping high seas.

Sea level rising is serious and personal,
here and now.

Changing the Climate with AD

• The AD cycle



- CHP
- Gas to Grid
- Industrial Boiler
- Drying Plant
- Vehicle fuel CNG
- = Reduction in CO₂

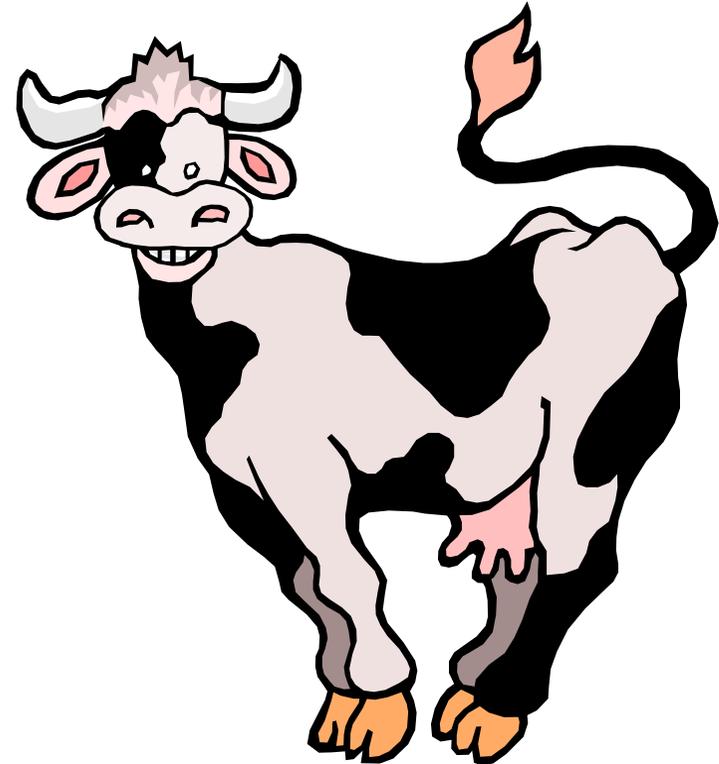
Tractor - mechanical

- Fuel/Oil Occasionally
- Store unattended in a shed until required
- Runs for 1000 hrs/yr
- Push the throttle – engine responds
- Eats Gas
- Makes Grass



Cow – living organism

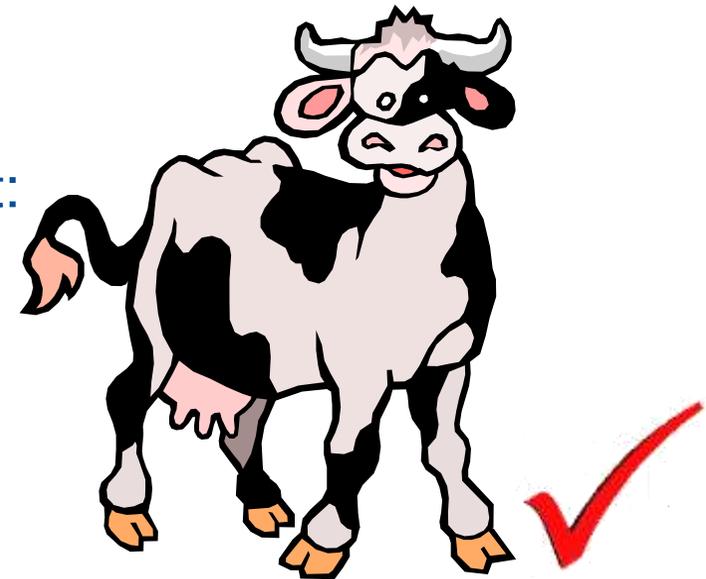
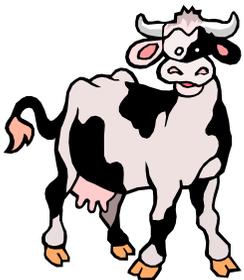
- Feed daily
- Cannot be stored + ignored
- Runs 8,760 hrs/year
- Takes days to respond but:
 - Overfeed - bloats
 - Underfeed - dies
- Eats Grass
- Makes Gas
- Produces effluent



Digester – Living Culture



- Feed daily
- Stores are active biological processes
- Runs 8,760 hrs/year
- Takes days to respond but:
 - Overfeed - foams
 - Underfeed - dies
- Eats Grass
- Makes Gas
- Produces effluent



***It's a Cow not a Tractor
All Cows Eat Grass***

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Grass is Great but Greasy



UK annual grass production is the largest agricultural sector (34.3 million tonnes dry matter per year)

If we are to remove beef from our diet to save the planet, then grass is a valuable energy source.

Grass is hydrophobic and floats in digesters. >50% grass feedstock is choking large scale digesters even at 4-15mm chop length. Enzymes are problematic in practice. Help!

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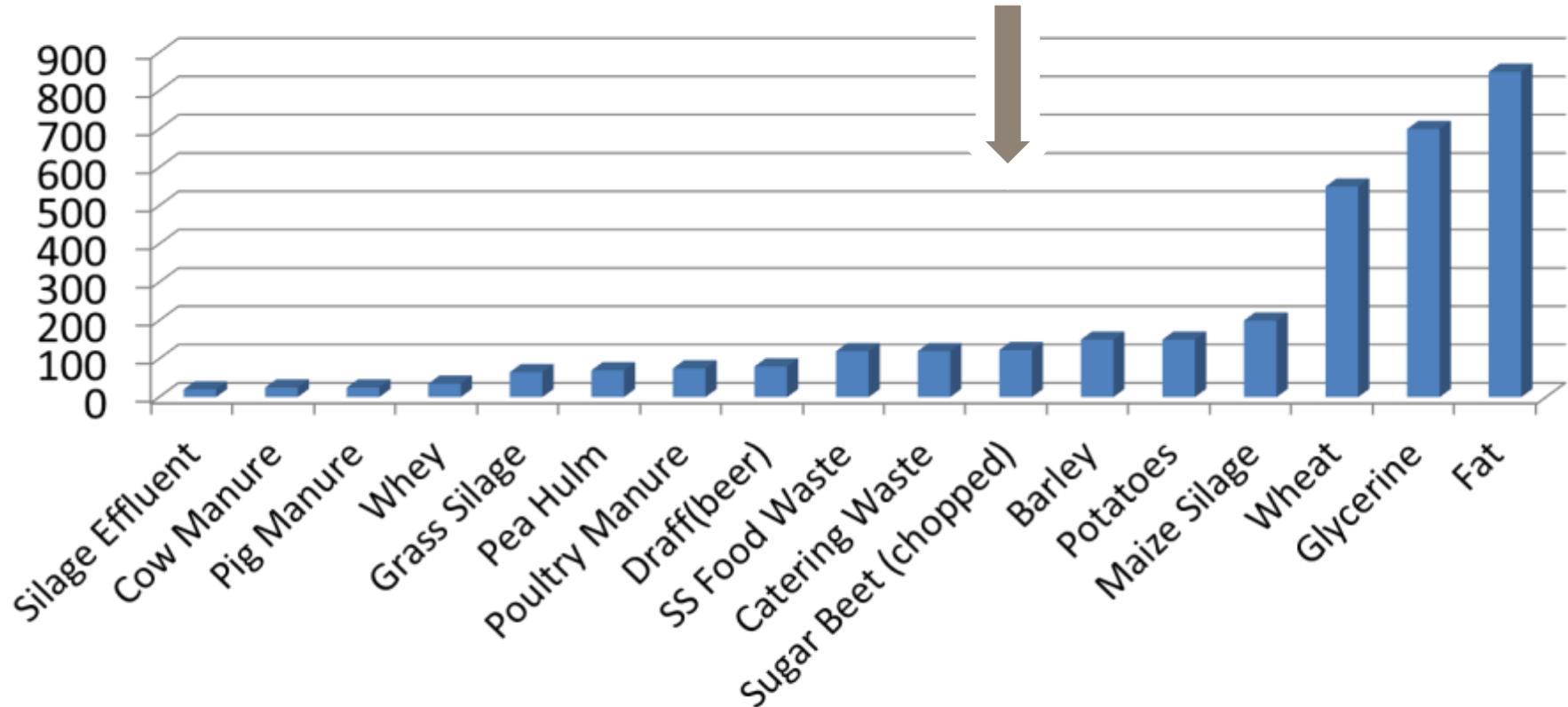
Feedstock - Available and Valuable

- 90-100 million tonnes of agricultural by-products like manure and slurry
- 16-18 million tonnes of food waste (from households and industry)
- 1.7 million tonnes of sewage sludge dry matter.
- **Each £10/T** in added value or saved cost
=£1,000Million per year to the country – **enough money to buy 2,000 primary schools a year.**

Feedstock – Land based (sea based?)

- Sea Organics stripped from plastic?

Gas Yield m3/T



Feedstock is important because:

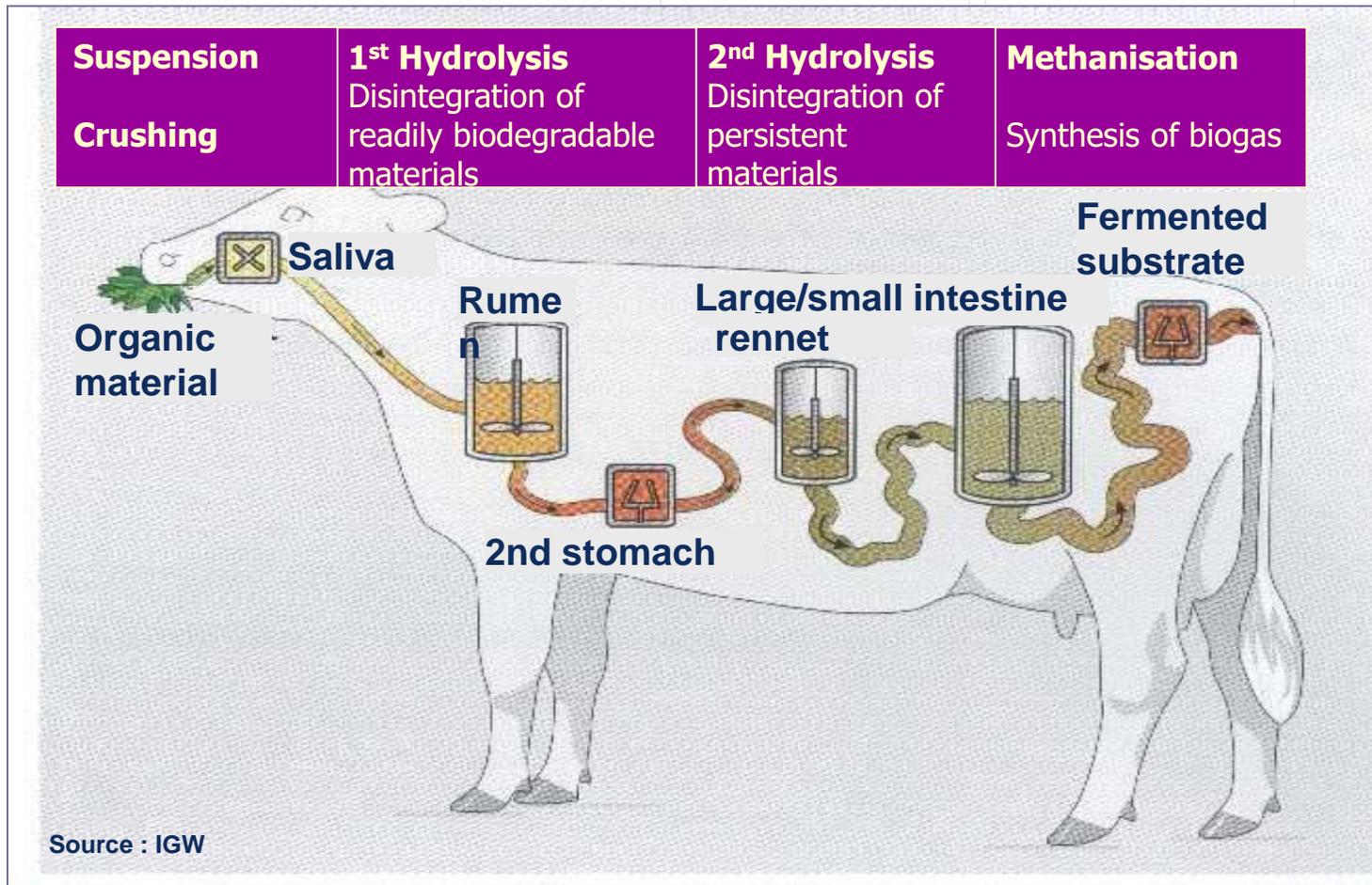
- Feedstock defines Regulations applied
- Feedstock controls Acidosis/Alkosis
- Feedstock controls Reaction Rate
- Feedstock produces Biogas
- Feedstock produces Compost Fibre
- Feedstock produces Liquid Fertiliser
- Feedstock determines Trucking costs
- Feedstock determines Pre-treatment
- Feedstock determines Digester selection
- Feedstock determines Gate fees
- Feedstock determines Landfill costs
- **Feedstock enables ocean plastic collection?**

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Tough part of the process | Easy part



DNA profiles of full scale digesters show amazing diversity – no two are alike. However,

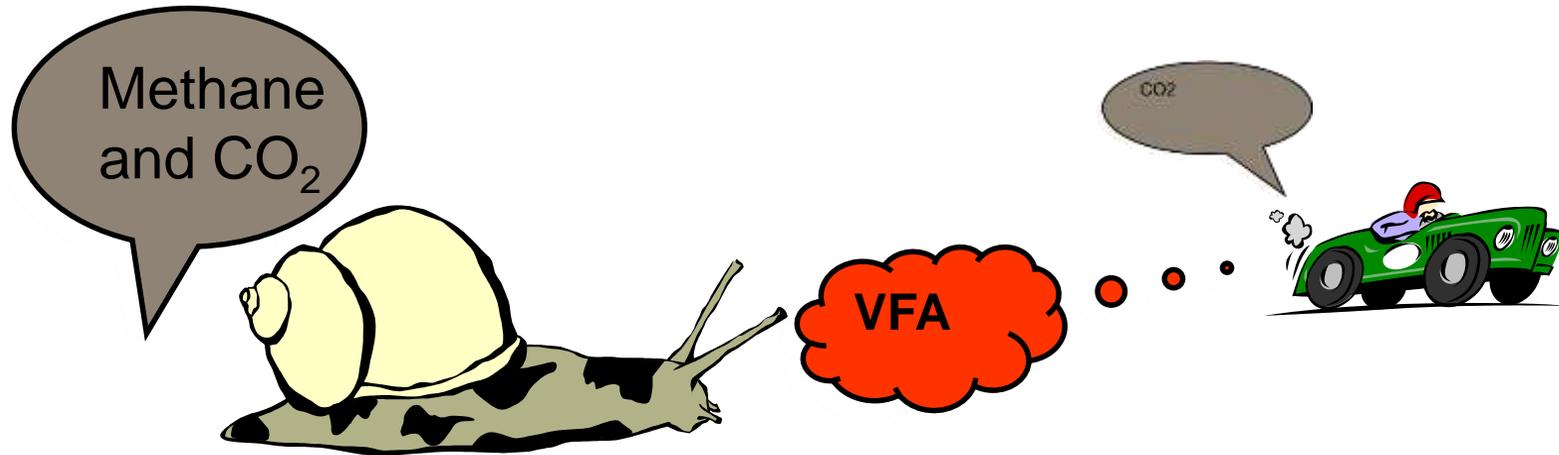
Acid forming Facultative bacteria comprise less than 1% per cent of the total acid-forming bacterial population. Obligate anaerobic acid-forming bacteria dominate.

Top Tip: Apply the biogas blanket to the headspace of acid hydrolysis tanks. This eliminates odour issues as the odour chemicals are burned downstream. Spikes of CO₂ need to be diluted.

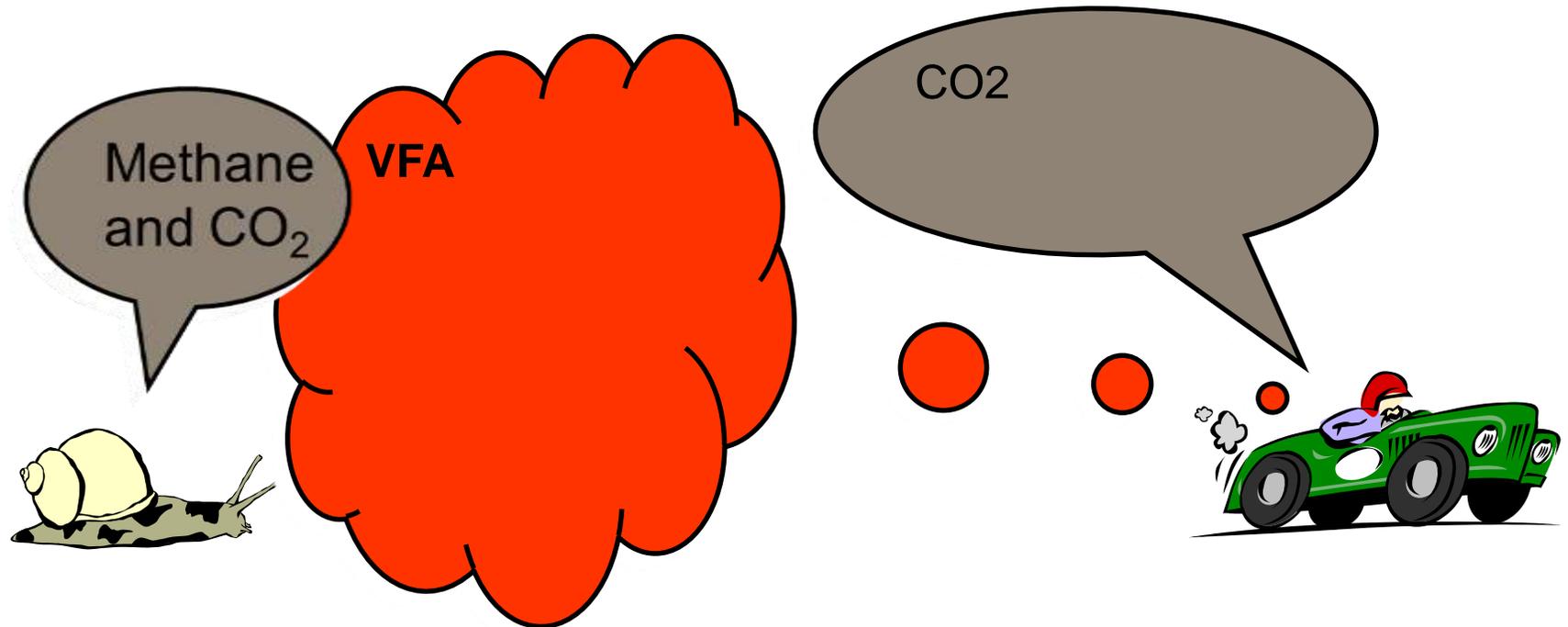


Thinking like a bacterium

- Microbial *archaea* origins relate to fossil stromatolites 3.5 billion years ago.
- The early earth had little or no oxygen in the atmosphere and an abundance of soluble metals.
- Se, Co, Ni, Mg – are still required by the *archaea* (*Thanks to Charles Banks and SOTON*)
- ***Top Tip – add trace elements***



- Slow methanogens (μ max 3 days ?) consume the VFA byproducts from the acetogens (μ max 3 hours ?)



- Shock Overloading or compromised acetoclastic archaea = relatively high CO_2 formation, foaming (soap is the salt of volatile acids) and ultimately the bacteria are pickled! **But how do you know if the acetoclastic archaea are healthy?**

Field analysis of acetoclastic archaea health



40ml of 5% acetic acid solution (Malt Vinegar) contains the substrate for acetoclastic bacteria to generate a handful of biogas in a minute

Acetate to gas can react in 15 seconds with healthy acetoclastic bacteria

However, if the Acetoclastic Archaea are absent, stressed or inhibited



It may take an hour to fill a finger with biogas.

Respiration gases are the first indicator of bacterial health

Take steps to look after the Acetoclastics if the population is compromised.

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It takes 1,000 years to make 3cm topsoil

At current rates of soil degradation all of the world's topsoil will be consumed in 60 years.

We have 60 harvests left

- 95% of our food comes from soil
- We are loosing 30 soccer fields of soil every minute due to intensive farming
- **In the UK I am told the topsoil will be consumed in 45 years – for some soils I have seen it is too late.**
- Humic colloid in digestate is a real solution and will regenerate a soil (my estimate) in 100 years

Using digestate to rebuild soils will save humanity

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Make it Beautiful:



- There are **many** more digesters to build and these have to recognise the sentiments of the general population so we **will need to make them beautiful**

Goddards Green gas bag
Reflected in primary settlement tank water LKG 1999

Make it Beautiful:



Make it Beautiful:



Buttercup Yellow!

Make it Beautiful:

Inspiration
can come
from many
places



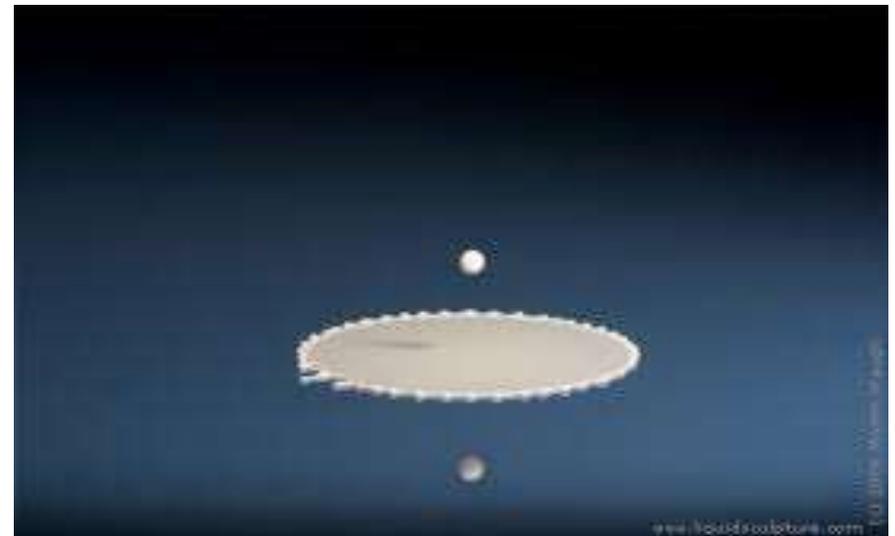
Splash



ecstaticist 2008



Reflection

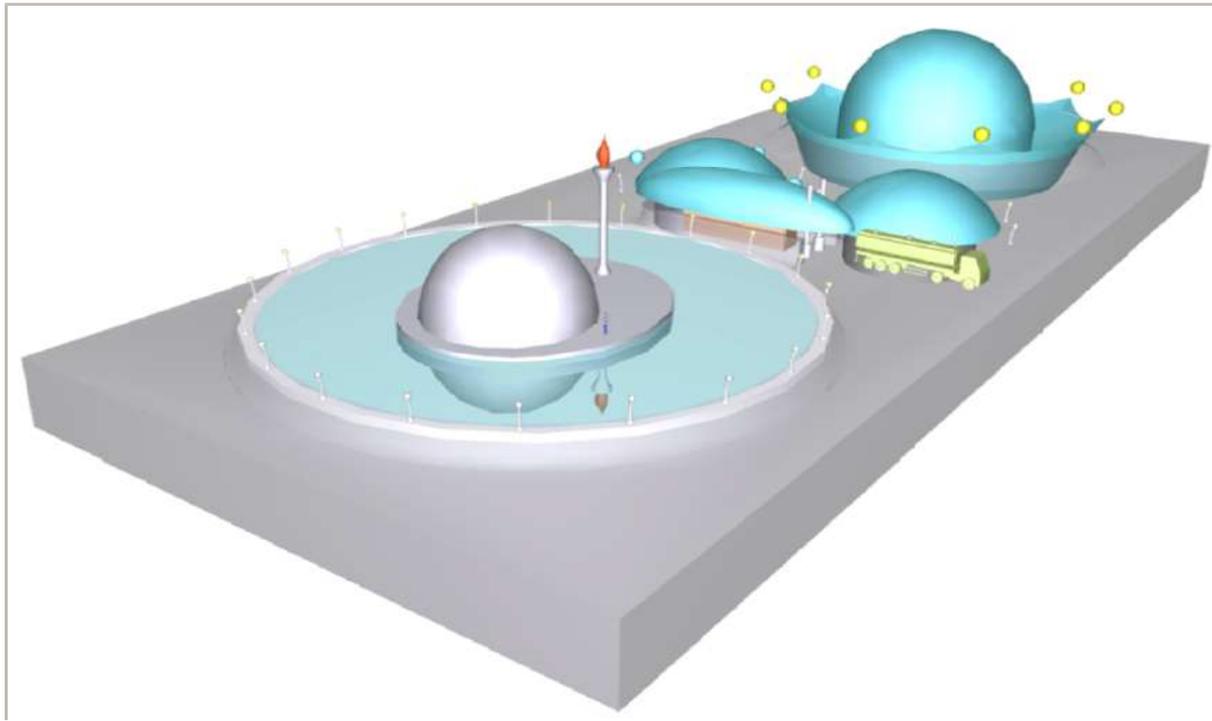


www.liquidsculpture.com

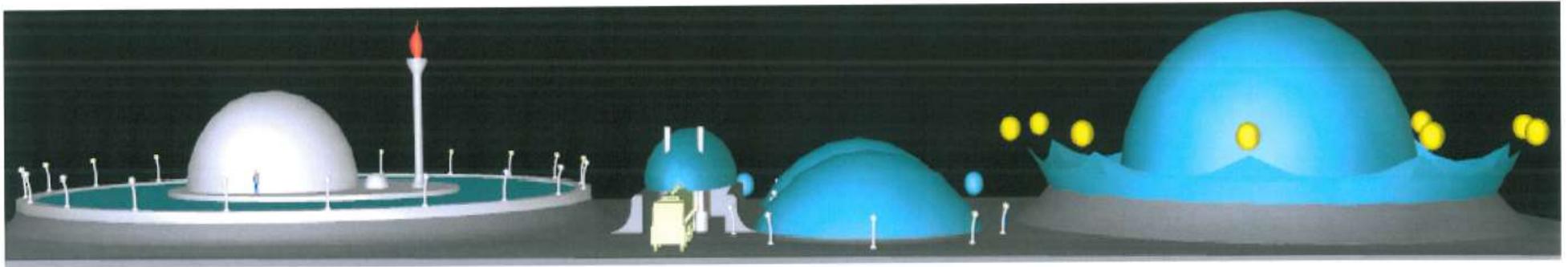
Make it Beautiful:

PROJEN - London Olympics digester – not built due to short notice

[COPYRIGHT 2012]



Make it Beautiful:



Make it Beautiful:



**2019 Biomethane
powered Tractor:**

**Running off organic
wastes from cows –
It's still a tractor not a
cow!**

**Create something beautiful with AD that saves the
world. We have 12 years to prevent global warming
and 60 years to prevent starvation.**

Thank You

- Dr Les Gornall
- BSc.(Hons),D.Phil, C.Biol. FRSB
- Process Consultant
- PM PROJEN
- DD: 01928 752 568
- Mob: 07921 388 422
- Email: les.gornall@PMgroup-global.com

