

Harvesting clean energy from organic waste: An overview



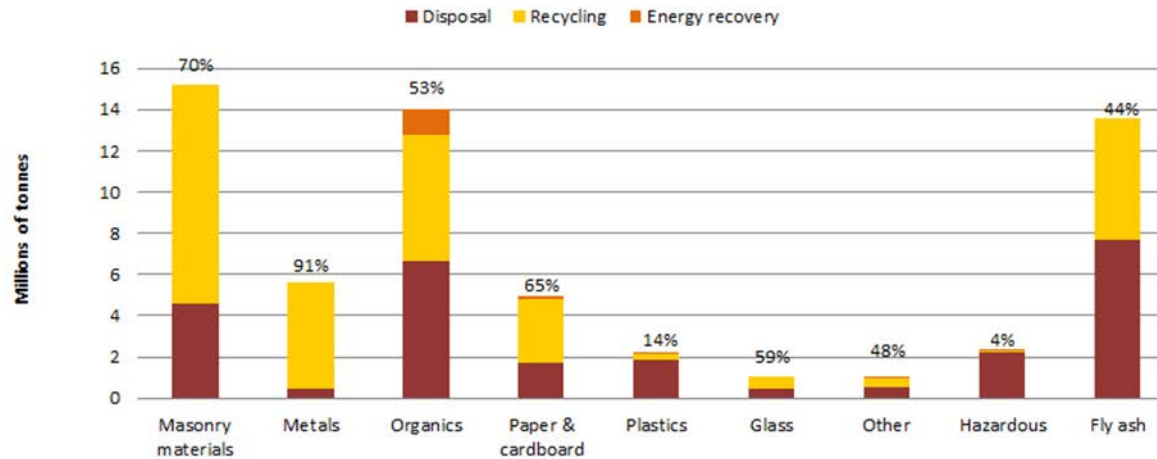
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NEWCASTLE

COOPERATIVE RESEARCH CENTRE FOR CONTAMINATION ASSESSMENT AND
REMEDiation OF THE ENVIRONMENT

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ORGANIC WASTE SOURCES

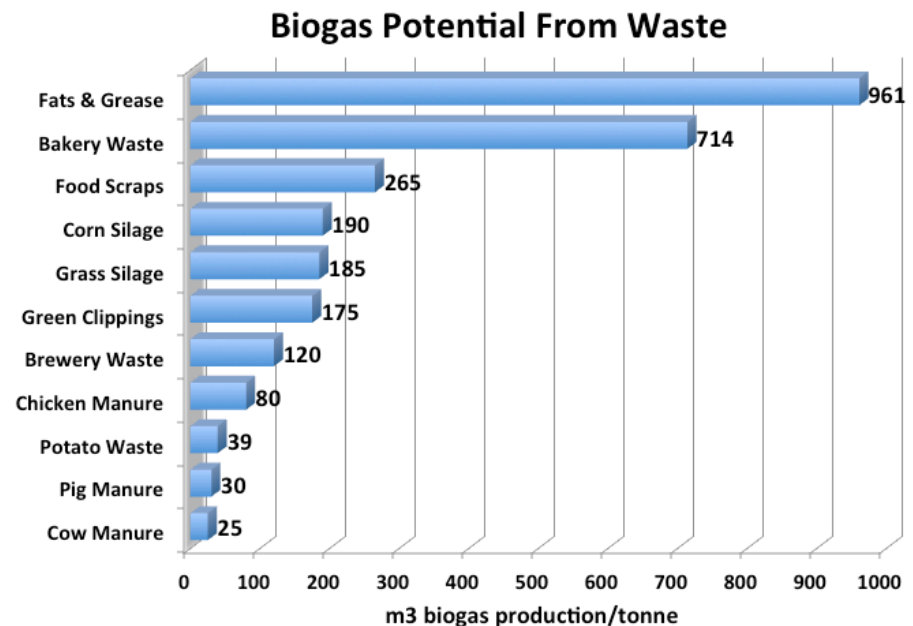


<http://www.environment.gov.au/system/files/resources/4b666638-1103-490e-bdef-480581a38d93/files/wgrra.docx>

Household	Food Processing
Agriculture Processing-veg/fruit	Livestock
Crop production	MSW source segregated
Wastewater	Green Waste

BIOGAS POTENTIAL FROM DIFFERENT WASTE

- Biogas potential differs depending on type and composition of waste
- Cow, Pig manure generates minimum amount of biogas per tonne of fresh matter
- Maximum biogas generation with food, bakery, fatty waste
- Co-digestion increases biogas potential with livestock manure and other industrial waste

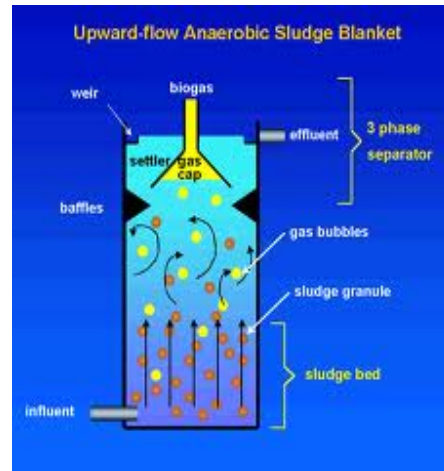


Large Scale Biogas Plants

Different technologies can be applied to generate clean energy in the form of biogas from waste streams, depending on the quality of waste

Most predominant are

- Covered Anaerobic Lagoon
- Up-flow Anaerobic Sludge Blanket
- Plug Flow
- Completely Stirred Tank Reactor



PRODUCTS OF ANAEROBIC DIGESTION: BIOGAS

Biogas can be utilised for

- Direct combustion
- Electricity generation
- Bio CNG

Direct combustion is the cheapest way of biogas utilisation.

Electricity generation: CHP engines / Micro turbines
: Utilise waste heat from engine
: Captive power consumption

Bio CNG : Purify the biogas to more than 95% methane
: Remove carbon dioxide and other gases
: Utilise it as a vehicular fuel

WHAT IS BIOGAS

Biogas is product from action of specific group of bacteria on organic waste in an anaerobic condition.

Biogas is typically a mixture of

- Methane 50-75%
- Carbon Dioxide – 24-45%
- Hydrogen sulfide-1-5%
- Moisture- 1-4%

Composition of biogas depends on

- Type of waste
- Type of technology
- Toxic level of contaminants

Calorific value range 18-28 MJ/m³



PRODUCTS OF ANAEROBIC DIGESTION: DIGESTATE

Digestate can be used as 'Organic fertiliser' for

- Direct application
- Solids separation
- Solids - packaging
- Liquid - hydroponics

Contains

- Nitrogen
- Potassium
- Phosphorus
- Carbon



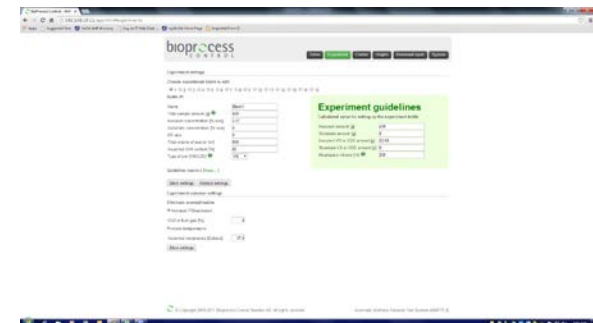
BIOMETHANE POTENTIAL TESTING

BMP Testing Advantages

- User friendly interface for experimental set up, real time data analysis and overview;
- Automatic real time pressure and temperature compensation for volume measurement;
- Replica of full scale system with temperature maintenance, mixing system, gas scrubbing and volume measurement;
- 4 samples tested in triplicate at a time with a set of blanks;
- mesophilic (moderate) temperatures as well as thermophilic (above 50 °C) temperatures; and
- Provides valuable information for design of full scale Anaerobic Digestion System.

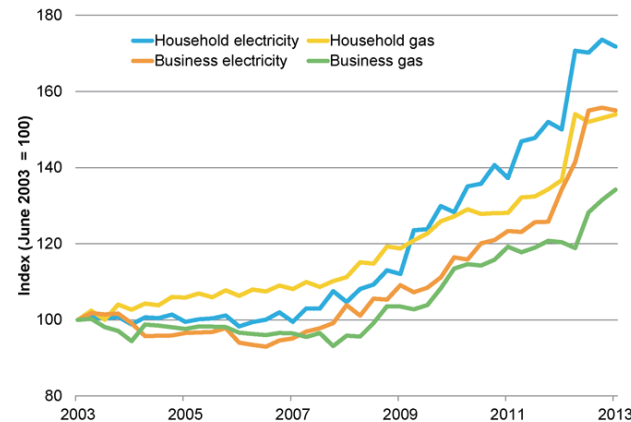


Automated Methane Potential Testing System-II



DRIVERS FOR HARVESTING CLEAN ENERGY

- Rising electricity price
- Rising tipping fees
- Rising natural gas
- Sustainability
- Environmentally friendly
- Odour



www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/BriefingBook44p/EnergyPrices

Australian gas prices predicted to triple by 2021

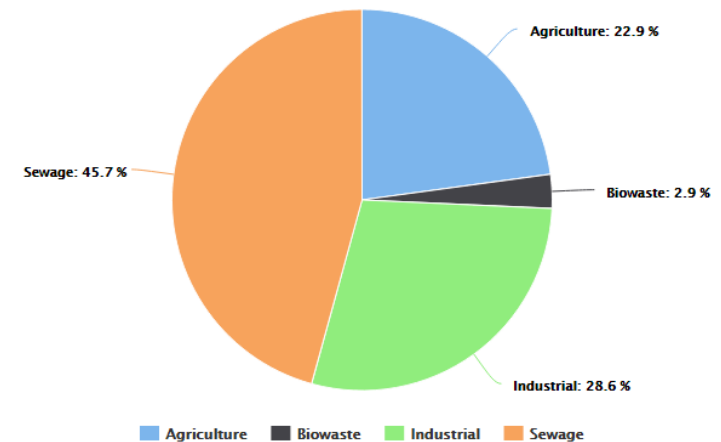
Anger as gas retailers lift prices in South Australia

Current Biogas Projects in Australia

- Most of the biogas projects in Australia are currently on Biosolids generated from municipal wastewater treatment plant
- Very few industrial or agricultural waste based biogas plant
- Not very well established technology
- Not aware of overall advantages

Number of records in feedstock categories

Feedstock Category	No. Records
Agriculture	8
Biowaste	1
Industrial	10
Sewage	16



<http://biogas.nceastg.usq.edu.au/biogas/#/summary>

Current Biogas Projects in Australia

Piggery waste streams

- Input :275 m³/d with 2% solids
- Output : 1700m³ biogas generating
2900kW electricity
100,000 l of mineralised water
7tonnes of solids at 35% dry
matter used as fertiliser

CSTR Technology

	Saving
Electricity	\$125,000
Water	\$50,000
Fertiliser	\$250,000
Total annual savings	\$425,000
Payback period	6 yrs



Current Biogas Projects in Australia

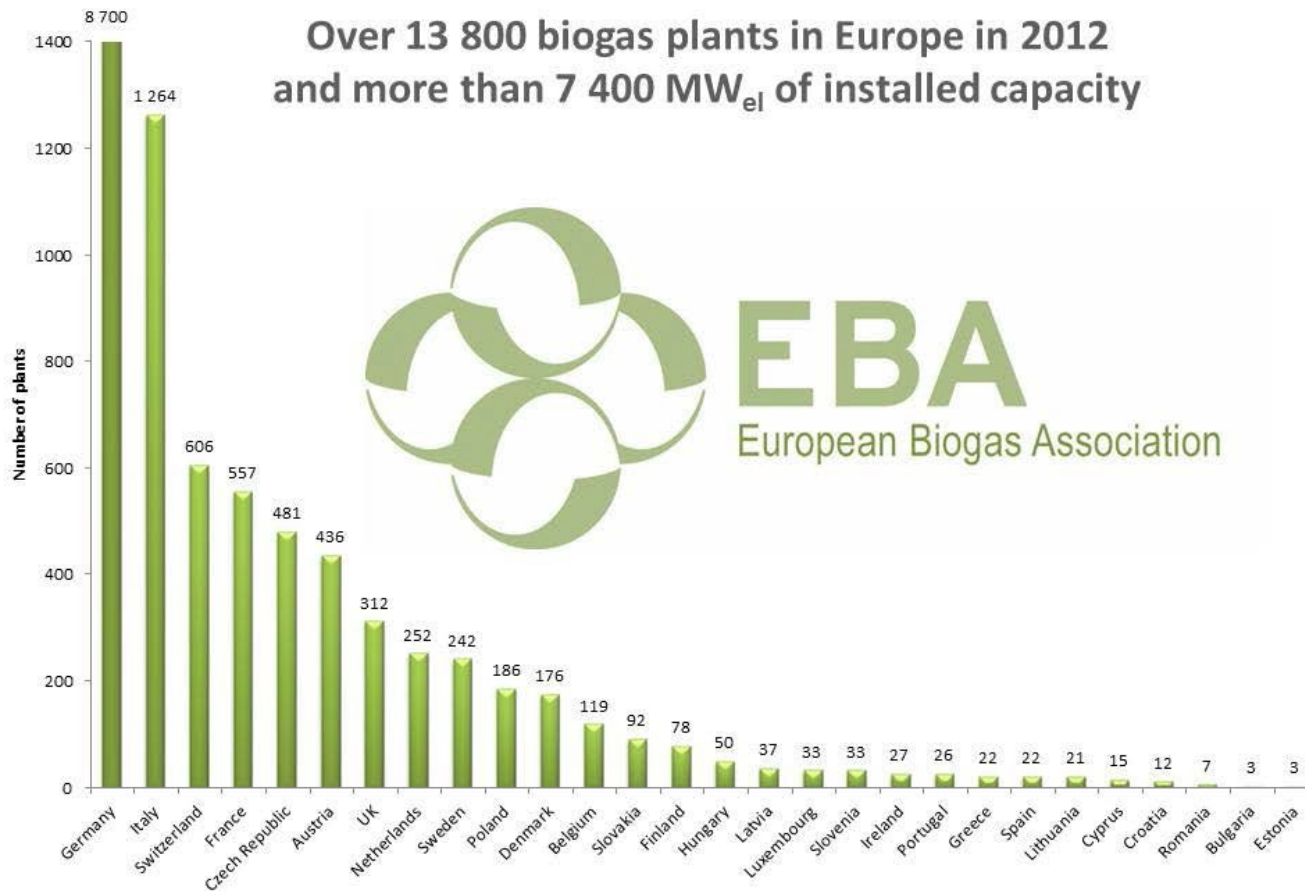
Lagoon based biogas plants

- Various lagoon based biogas plants are installed in Australia in agriculture, food and municipal sector
- Predominantly found in Piggery, dairy, abattoir industry
- Leongatha Dairy Victoria 0.76MW
- Blantyre Farm piggery – 22000 pigs
- JBS Australia abattoir- 10MW boiler gas replacement

And many more....



BIOGAS PLANTS: EUROPE



http://european-biogas.eu/wp-content/uploads/2014/01/Biogas-plants-in-2012_graph.jpg

EBA 2012

LINKÖPING, SWEDEN - A UNIQUE CASE

Biogas is purified to bio-methane.

Used in local transport/bus/cars/trains.

Bio-methane plant upgrade

1992 - 200 m³/h

1997 - 660 m³/h

2002 - 1400 m³/h



Bus filling station and public refuelling stations.

5 million m³ biogas saving about 5 million litre diesel

CO₂ emission reduction by 9000t/y

No Dust, sulfur and N₂O

Fertiliser replacement – 17 farmers

CAPITAL COST, OPERATIONAL COST AND PAYBACK

Waste	Flow	Capex , \$ M	Payback period, years	Power Generation
Piggery	160 m ³ /d	\$4-5	~ 6	80kWe
Vegetable and fruit	20 t/d	\$3-4	~ 3.5	200kWe
Giant Reed Grass	20 t/d	\$	-	110kWe
Cow Manure	100 t/d	\$	-	150kWe

CASE STUDY : PIGGERY

Quantity of pig manure: 160 m³/d with 2.9% solids

Scenario 1: Piggery without solid separation

Organic Waste, m ³ /year	58400
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Type of waste	Piggery
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Feed tank, m ³	300
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Digester volume, m ³ , total	4000
Number of tanks	2
Tank Height, m	7.5
Gas production, m ³ /y	468,000
Methane content, %	62
Average energy, MW/y	946

Capex, \$M	4,500,000
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TOTAL REVENUE, \$	790000
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Electricity, Heat, Digestate, CFI

Payback, yrs	5.7
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CASE STUDY : PIGGERY

Quantity of pig manure: 160 m³/d with 2.9% solids

Scenario 2: Piggery with solid separation

Organic Waste, m ³ /year	21900
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Type of waste	Piggery
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Feed tank, m ³	150
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Digester volume, m ³ , total	1500
Number of tanks	1
Tank Height, m	7.5
Gas production, m ³ /y	468,000
Methane content, %	62
Average energy, MW/y	946

Capex, \$M	2,500,000
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TOTAL REVENUE, \$	700000
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Payback, yrs	3.5
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CASE STUDY : PIGGERY

Quantity of pig manure: 160 m³/d with 2.9% solids

Variables:

Technology : Covered anaerobic lagoon
CSTR

Biogas utilisation : Direct combustion or
Electricity

Waste characteristics : As such or solid separated

Current rate of electricity : \$200-\$350/MW

Current rate of Gas : ???

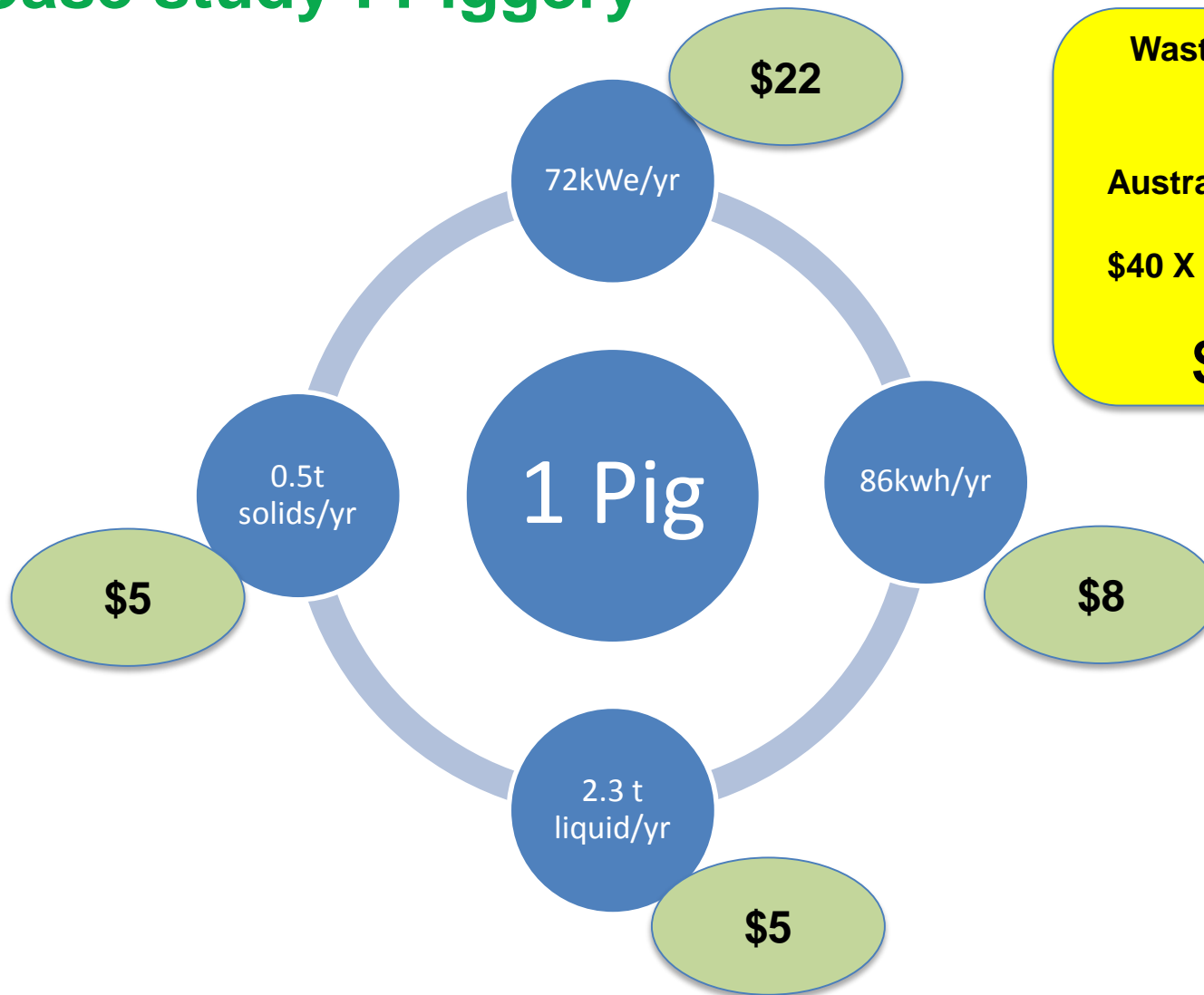
Automation involved : ??

Specific Unit in AD : Civil, MS, SS, GFS

Revenues : Electricity, gas, water,
fertiliser, CFI, LGC, gate fees

PorkCRC published report with 1.8 to 8.45 years pay back with 5 different piggeries.

Case study : Piggery



Waste from 1 pig is worth
\$40

Australia has 2.1 million pigs
Equivalent to
 $\$40 \times \$2.1\text{ Million} = \$84\text{ Million}$
Even 50% of it

\$ 42 Million

FEEDLOT STATISTICS

<i>State</i>	<i>Cattle on feed (06/09)</i>	<i>Domestic SCU*</i>	<i>Export SCU</i>	<i>Total SCU</i>	<i>t/SCU/Yr</i>	<i>t/Yr (manure)</i>
	(No. of head)					
NSW	222,216	57,998	164,884	222,883	1.0	222,883
Vic	44,411	11,591	32,953	44,544	1.0	44,544
Qld	415,099	108,341	308,003	416,344	1.0	416,344
SA	18,027	4,705	13,376	18,081	1.0	18,081
WA	43,700	11,406	32,425	43,831	1.0	43,831
Total	743,453	517,443	157,612	675,055	1.0	675,055

* SCU- Standard cattle unit

CURRENT CHALLENGES

Increased

Utility cost

Electricity

Gas

Transportation

Waste Management Cost

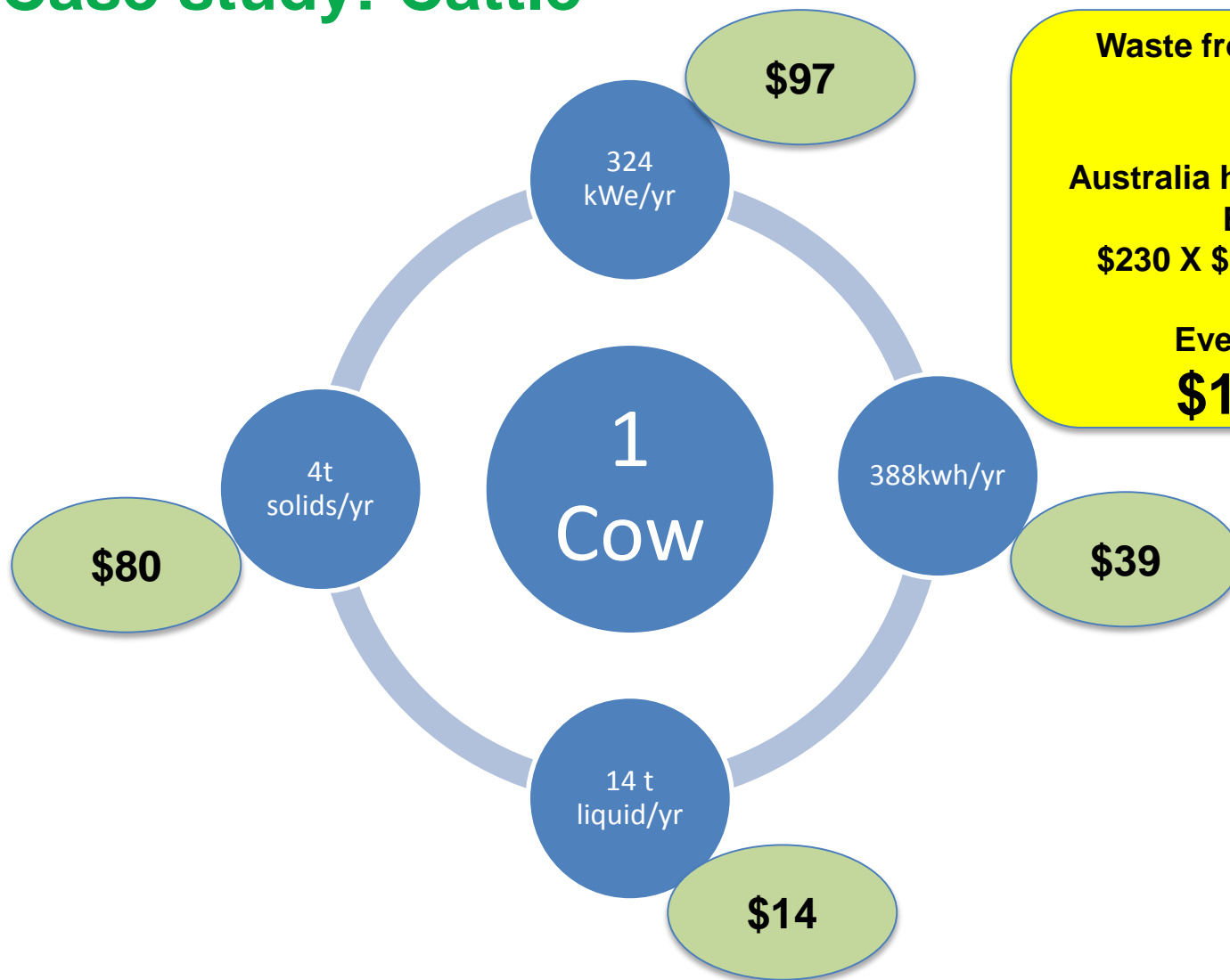
Disposal

Treatment

Market competition



Case study: Cattle



Waste from **1 COW** is worth
\$230

Australia has **28.5** million cattle
Equivalent to
 $\$230 \times \$28.5 \text{ Million} = \$6.555$
Billion

Even 20% captured
\$1.3 Billion

Food for Thoughts.....

Fertiliser value from Digestate

Phosphorous is depleting fast

N,P,K and other micronutrients currently wasted in the region?

Mapping of wasted macro and micronutrients

Sulfur recovery from biogas

20160 m³/d biogas with 1% H₂S- 288 kg/d recovery

BIOGAS TO BIOGNG

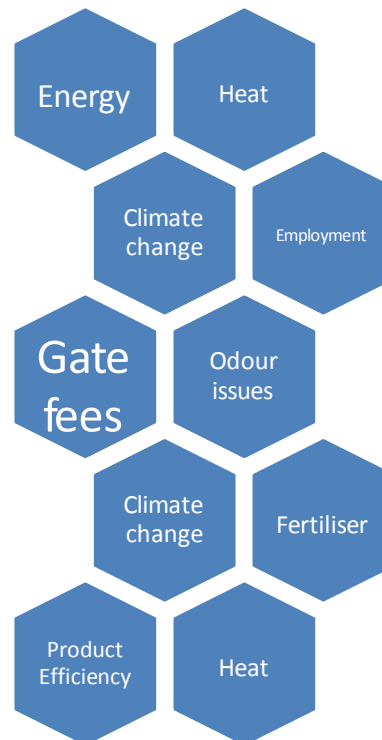
BIOGAS to BIOGNG *How practical is it?*

Community level AD

Centralised Anaerobic Digestion for Decentralised Power

SUMMARY

- **Australia has substantial resources to generate BIOGAS**
- **Various biogas technologies can be implemented on case to case basis**
- **Economic empowerment from BIOGAS industry, if well organised can reduce GHG emissions, generate employment as well save environment.**
- **Biogas gives multiple benefits**



WHERE FROM HERE.....

Together ...



... We Can

.... A WtE Revolution.....

Questions Welcome....

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