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#### The 4<sup>th</sup> 'R' - Recover

Anaerobic Digestion for Energy Recovery from Organics



# Disclaimer

- The information in this presentation was prepared for the SENG "War on Waste" session on 3 July 2018.
- The information in this presentation is for illustrative purposes only and should not be used to make project, investment or financial decisions.
- The information is generic and is not applicable to specific projects and situations.
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### Waste to Energy (W2E) – Where it fits In



Source: "The role of waste-to-energy in the circular economy ", COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS, Brussels, 26.1.2017 COM(2017) 34 final.



### Scope

#### W2E Options

- Thermal (combustion, pyrolysis, gasification, torrefaction, thermal depolymerisation)
- Biological / Biochemical (anaerobic digestion, fermentation)

#### Anaerobic Digestion (AD)

- EU Treatment
- Suitable Feedstocks
- Recoverable Energy
- By-products
- Implications of QLD \$70/t landfill fee



# All Energy Pty Ltd personnel previous works:

#### **Existing Facilities - Operational Optimization and Engineering Works:**

- Bears Lagoon Piggery Waste to Biogas, VIC
- Melbourne Water Western Treatment Plant
- Oakey Beef Exports COHRAL system, QLD
- BE Campbell, Young NSW
- Kilcoy Pastoral Company (food manufacturing), QLD
- Audits for biogas cogeneration facilities creating renewable Energy credits (RECs) [current]

#### Front End Engineering Design (FEED) and Feasibility Studies:

- Brisbane Airport Authority FEED and ARENA application.
- UnityWater: feasibility screening tool for waste to energy.
- Gladstone Regional Council: FOGO and waste water sludge
- Australian Country Choice (food manufacturing), QLD
- Wood Mulching Industries, Mixed organic and green wastes, QLD
- Opal Creek Feedlot and Grain Flaking, QLD
- Kerwee Feedlot and Grain Flaking, QLD
- Trisco Foods, QLD
- Monash University, Mixed FOGO and sewer mining, VIC
- Dalby Biorefinery Pty Ltd (ethanol from grain), QLD
- Chicken industry wastes to renewable energy: scenic Rim and Western Downs, QLD
- Meat and Livestock Australia: Waste to energy throughout the red meat supply chain.
- Australian Meat Processing Corporation: Organic waste to energy.



### **Biomass and Waste to Energy - Options**





| Waste to<br>Energy<br><sub>Tech</sub> | Temp.        | O2<br>Level | Gas Comp                                     |                |     |    |                                      |                                      |  |
|---------------------------------------|--------------|-------------|--|----------------|-----|----|--------------------------------------|--------------------------------------|--|
|                                       | °C           | %           | CH <sub>4</sub>                              | H <sub>2</sub> | CO2 | CO | Primary<br>Products                  | Further<br>processing                | Advantages                             |
| Torrefaction                          | 200-320      | 0           |  |                |     |    | Syngas, bio-char,<br>condensables    | Energy pellets                       | Low temp & pressure                    |
| Pyrolysis                             | 400-650      | 0           | 9  | 36             | 7   | 17 | Syngas, bio-char<br>&/or bio-crude   | Power;<br>Fertilizer                 | Low pressure;<br>No ash                |
| Gasification                          | 650-850      | 20          | 3  | 18             | 6   | 24 | Heat, syngas, ash                    | Methanol,<br>hydrogen,<br>syn-diesel | "Clean" syngas                         |
| Combustion                            | 850-<br>1000 | 125         |  |                | 11  |    | Heat and Ash                         | Power                                | Heavy metals<br>inert in slag /<br>ash |
| Anaerobic<br>digestion                | 35           | 0           | 52   |                | 48  |    | Digested sludge,<br>treated effluent | Fertiliser                           | Process wet<br>biomass                 |
| Organic<br>Rankine Cycle              | ~>80         |             | Any heat source.<br>Thermal oil is<br>ideal. |                |     |    | Power                                |                                      | No fuel costs                          |

First and Foremost – AD can be considered a recycling operation rather than recovering energy!

European Commission publication "The role of waste-to-energy in the circular economy" (2017):

"processes such as anaerobic digestion which result in the production of a biogas and of a digestate are regarded by EU waste legislation as a recycling operation"



European Commission publication "The role of waste-to-energy in the circular economy" (2017):

"Waste to energy is a broad term that covers **much more than waste incineration**. It encompasses various waste treatment processes generating energy ... each of which has different environmental impacts and circular economy potential."

"Improving the energy efficiency of waste-to-energy processes and promoting those processes which **combine material and energy recovery** can contribute to decarbonising key sectors ... and to reducing greenhouse gas emissions from the waste sector."

"Waste-to-energy processes can play a role provided that ... choices made do not prevent higher levels of prevention, reuse and recycling.



### What does this mean?

- Anaerobic Digestion ranks higher on the waste hierarchy as it involves energy and material (concentrated NPK digestate) recovery
- Excellent choice for volatile waste organics

Let's look further at the technology...



# AD – Feedstocks

Ideal feedstocks are:

- High "biomethane potential" as delivered: m^3 biogas per tonne delivered
- High solids content and volatile solids content (dry and fresh) as this keeps transport costs down on a \$/m^3 biogas basis.
- Organic
- Steady supply
- Examples
  - Food processing waste
  - Municipal organic waste (food scraps, green waste)
  - Grease trap waste
  - Water treatment wastes (activated sludge, DAF sludge)
  - Agri wastes and green wastes
- Waste streams are often varied and complex and should be considered on a case by case basis



#### Automated Feasibility SaaS Platform Tool

HOME SUB

SUBMIT YOUR BILL INFO HERE! WASTE TO ENERGY

BIOGAS TO POWER S

STEAM AND HOT WATER SOLAR PV + LI-ION BATTERY

#### Waste to Energy

#### SOLID WASTE TO ENERGY TOOL - Enter your data here:

| W2E - COPYRIGHT        | ALL E  | NERGY P1                             | Y LTD 2  | 2018 - SC                        | LID WA | STE TO E  | NERGY  |  |                   |   |          |                      |                 |         |      |
|------------------------|--|--------------------------------------|----------|----------------------------------|--------|---|--------|--|-------------------|---|----------|----------------------|-----------------|---------|------|
| Basis of Analysis:     | 8,008 facility hours per annum (4 weeks scheduled shut down; 97% availability) |                                      |          |                                  |        |   |        |  |                   |   |          |                      |                 |         |      |
|                        |  | 128,000                              | Populati | ion service                      | ed     |   |        |  |                   |   | Target N | ICV:                 | min             | 8.5.    |      |
|                        |  | 90.4% % of total ash as bottom ash   |          |                                  |        |   |        | Boiler efficiency  |                   |   | 87.3%    |                      |                 |         |      |
| All Energy Pty Ltd     |  | 99.9% % volatilation DW              |          |                                  |        |   |        |  | Gen set efficienc |   |          | . 19.1%              |                 |         |      |
| 2. MASS BALANC         |  |                                      |          |                                  |        |   |        |  |                   |   |          |                      |                 |         |      |
| Stream Description     |  | Mixed Municipal<br>Solid Waste (MSW) |          | Food Organics /<br>Waste Orgaics |        | Segregated Wood;<br>Residual Waste<br>Fuels (RWF) at<br>11%w/w of |        | Supplementary<br>high NCV fuel<br>(shredded and<br>debeaded tyres) -   |                   | Gross Therm<br>otal Fuel Energy Movi<br>Grate |          | ermal<br>loving<br>e | Gross Electrica |         |      |
| Stream #               |  |                                      |          |                                  |        | A A   |        | and the second s |                   | 5   |          |                      |                 |         |      |
| Mass Flow ww (tpa)     |  | 95,502                               |          | -                                |        | 10,494  |        | 31,061   |                   | 168,119                                       |          |                      |                 |         |      |
| Density (kg/m^3)       |  | 550                                  |          | 700                              |        | 550   |        | 600  |                   | 550   |          | )                    |                 | 11.52   | MW   |
| NCV / LHV (MJ/kg)      |  | 9.00                                 |          | 9.00                             |        | 12.2  |        | 33.0   |                   | 10.34   |          | 1,738,837            | GJ pa           | 92.25   | GWhp |
| Component Flows        |  | kg/h                                 | mass %   | kg/h                             | mass % | kg/h  | mass % | kg/h   | mass %            | kg/h  | mass %   |                      |                 |         |      |
| SOLIDS                 | Mol. W   | 11,925                               |          | -                                |        | 1,312   |        | 3,882.7  |                   |   |          |                      |                 |         |      |
| Biomass (as delivered) |  | 7,346                                | 61.6%    | -                                | 100.0% | 1,311.79  | 100%   |  | 28%               | 10,929  | 63.8%    | -<br>-<br>-          |                 |         |      |
| Dry weight             |  | 7,513.0                              | 63%      | -                                | 26%    | 1,096.7   | 83.6%  | 3,858.6  | 99.38%            | 15,509  |          |                      |                 |         |      |
| Ash                    | <u> </u>   | 548.4                                | 7.30%    | -                                | 15.00% | 11.0  | 1.00%  | 185.6  | 4.81%             | 1,193   | 6.97%    |                      |                 |         |      |
| Volatile matter        | VS/TS%   | 6,250.04                             | 83.2%    | -                                | 91.0%  | 924.48  | 84.3%  | 2,587.6  | 67.06%            | 9,762   |          |                      |                 |         |      |
| Fixed carbon           |  | 715.2                                | 9.5%     | -                                | 64.0%  | 192.8   | 14.7%  | 1,085.4  | 28.13%            | 1,993   |          |                      | (               |         |      |
| C (ash free)           | 12.01  | 3,691.20                             | 53.00%   |                                  |        | 549.36  | 50.60% | 3,256.3  | 84.39%            | 9,046   | 65.49%   |                      |                 |         |      |
| H (ash free)           | 1.01   | 508.41                               | 7.30%    |                                  |        | 69.48   | 6.40%  | 275.1  | 7.13%             | 1,043   | 7.55%    |                      |                 |         |      |
| O (ash free)           | 16   | 2,157.61                             | 30.98%   |                                  |        | 455.01  | 41.91% | 84.5   | 2.19%             | 3,472   | 25.13%   | All Energy P         |                 |         | Ltd  |
| N (ash free)           | 14.01  | 91.93                                | 1.3%     |                                  |        | 0.87  | 0.08%  | 9.3  | 0.24%             | 128   | 0.93%    |                      |                 | 9/ • •/ |      |
| Chloride (Cl)          | 35.45  | 16.02                                | 0.2%     |                                  |        | 0.22  | 0.02%  |  |                   | 67  | 0.49%    |                      |                 |         |      |
| Sulphur (ash free)     | 32.07  | 6.96                                 | 0.1%     |                                  |        | 0.11  | 0.01%  | 47.8   | 1.24%             | 57  | 0.41%    |                      |                 |         |      |
| WATER (Liq or gaseous) |  |                                      |          |                                  |        |   |        |  |                   |   |          |                      |                 |         |      |
| H2O in feedstock       | 18.02  | 4,412.38                             | 37%      |                                  |        | 215.13  | 16%    | 0  | 0.62%             | 5,469   | 32%      |                      |                 |         |      |
|                        | 18.02  |                                      |          |                                  |        |   |        |  |                   |   |          |                      |                 |         |      |

All Energy Pty Ltd www.allenergypl.com.au

### Example PFD: Biogas from organic waste



Approximately 63% of QLD landfilled MSW is biogenic

- Opportunity for AD
- Not currently
  economic to
  separate biogenic
  fraction
- Additional bins
  may be viable after
  landfilling price
  threshold





### Recoverable Energy / Material

#### • Biogas (CH4 / CO2 / trace)

- CNG
- Pipeline
- Generation
- Co/Tri-Generation
- Concentrated NPK Digestate
  - Composting
  - Cropping

What sort of revenues does this generate?



### **Potential Revenues**

- Feedstock
  - Under landfill levy or for particularly problematic wastes, worst case delivered for cost of transport, best case charge gate fee; and/or
  - Avoided waste management fee e.g. from a food processing facility
- Power / Thermal Offset
  - For rural business, previous work has shown value of 1 m3 of biogas as \$0.49 for boiler fuel, \$1.38 and \$0.61 for peak and offpeak power respectively
  - Much greater value in power offset
- Renewable Energy Credits from power generation



### **Motivation for Onsite Energy Generation**

- Power
- Heating fuel
- Waste management
- Disposal options
- Waste Stewardship
- Energy & cost security

Reducing Increased pressure Increased demand

- Renewable Energy Credits
- Emissions Reduction Fund
- Gate fees

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### Energy - Threats and Opportunities

#### Threats:

- Large variability in wholesale prices
- Large variability (normally upwards) in fuel prices
- Regulatory / legislative changes e.g. carbon pricing
- Increasing waste management costs
- Development approvals and EPA

#### Opportunities:

- Energy security
- Disruptive fuel sources: CNG; biomass; recycled wood / pellets; biogas.
- Disruptive technologies: distributed generation, energy storage
- Businesses surrounding you also want cheap and green energy

# Qld Landfill Levy

- \$1.3 billion in revenue from the levy over the next four years.
- Basis: \$70 / tonne levy on 4.64 mil tonnes of landfill pa; commencing 2019 (TBA; ~1 July).
- Govt will retain ~30%: \$390 mil over 4 years.
- ~29 to 30% "no direct impact on households": \$381 to 390 mil over 4 years.
- Balance on "waste management strategy": \$529 mil over 4 years.
- Councils would receive \$32 million worth of advanced payments in 18-19.
- \$100 mil for funding of resource recovery projects.

Q: Where is the other \$429 mil going ???

**Data sources:** https://www.ehp.qld.gov.au/waste/pdf/recycling-waste-qld-2017-report.pdf Rockhampton RC "Council-Ordinary-18-06-26-Agenda-Supplementary%20(1).pdf", 26 June 2018. https://www.brisbanetimes.com.au/politics/queensland

