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Introduction to Biogas

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What is Biogas?

- A gaseous mix produced from the anaerobic digestion of organic substances
- Typically around 60-70% methane (CH_4) and 30-40% carbon dioxide (CO_2)
- Can also include small amounts of oxygen (O_2), nitrogen (N_2) and traces of hydrogen sulphide (H_2S), and other impurities
- As it is produced in a wet environment, biogas will typically include significant amounts of moisture

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What is Anaerobic Digestion (AD)?

- A completely naturally occurring phenomenon
- A sequence of biological processes, facilitated by a large number of different micro-organisms (anaerobic bacteria), in an oxygen-free environment
- The bacteria break down hydrocarbons and proteins, to form CH_4 and CO_2 with traces of impurities such as H_2S
- The remaining sludge residue has minimal organic matter, is high in nutrients (Nitrates, Phosphates and Potassium) and makes an excellent fertiliser

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History

- First observed in ancient times as “Marsh Gas”
- May have been used for heating purposes as early as 16th C
- The first “modern” anaerobic digester was built in India in 1859
- Domestic and farm-scale biogas plant have developed rapidly in China and India since 1960’s, due to government incentives
- Millions of biogas plants in India and 10’s of millions in China
- In Europe, the past 2 decades have seen an exponential growth in biogas plants, with Germany leading the way at over 9 000 plants installed

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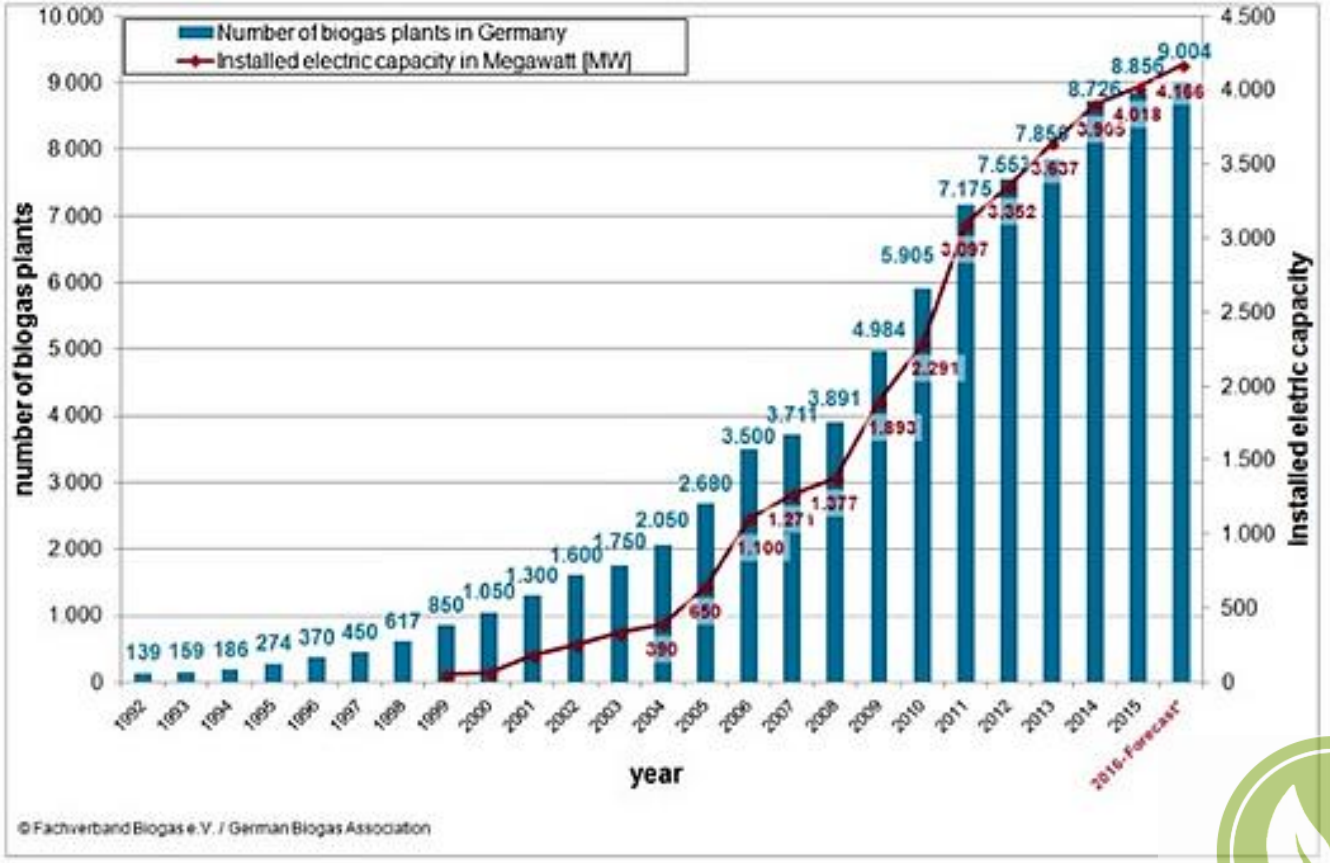
History

Development of the number of biogas plants and the total installed electric output in megawatt [MW] in Germany (as of 07/2016)



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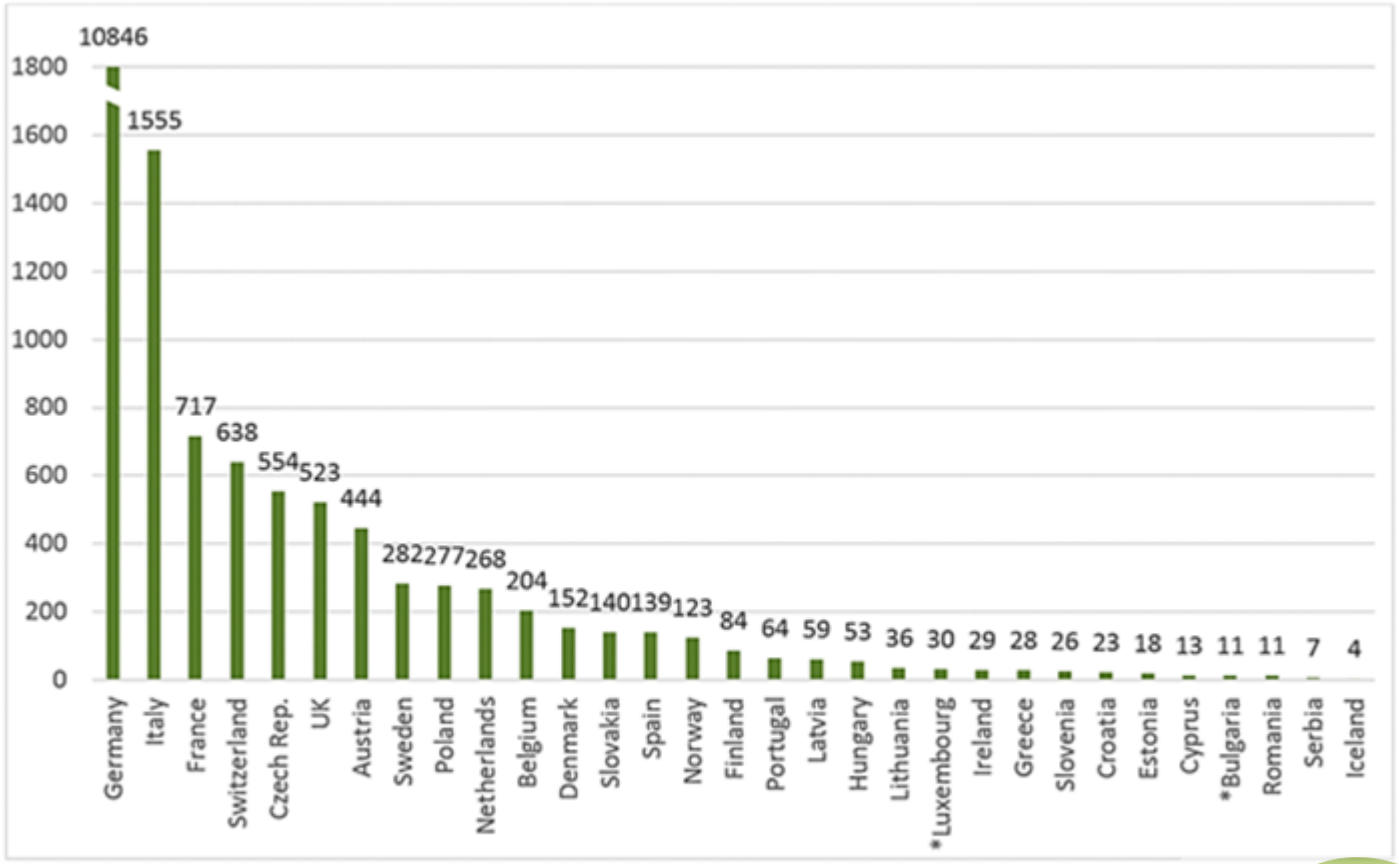
Current European Status



17,358 biogas plants in Europe

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Modern Biogas Design

- Feedstock pre-treatment, mixing
- Metering of feed to digeters
- Primary digester
  - Thermophylic/Mesophylic
- Secondary digester
- Gas collection and storage
- Gas cleaning & drying
- CHP
- Digestate treatment and separation
- Water recycling

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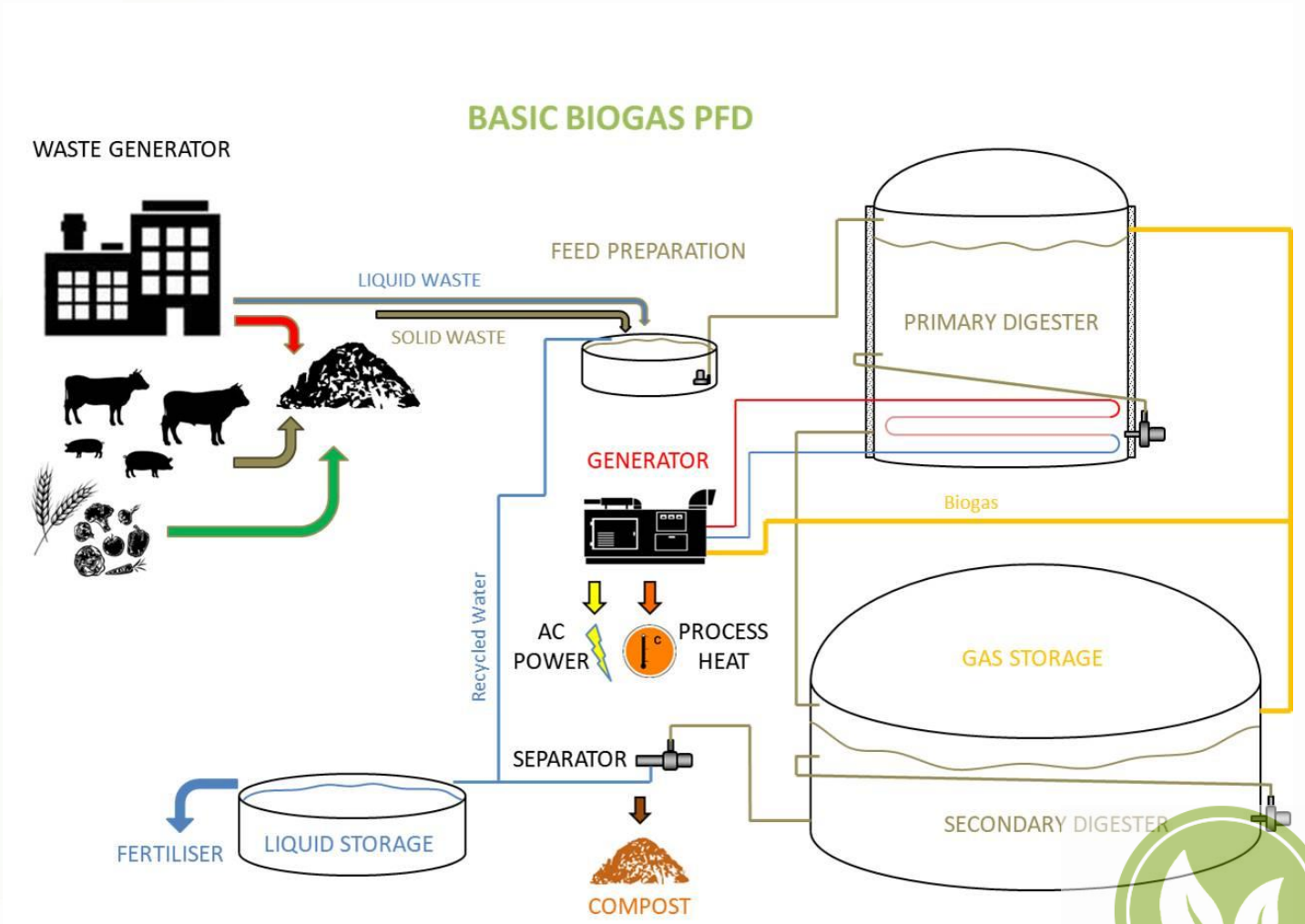
AD Process Flow Diagram



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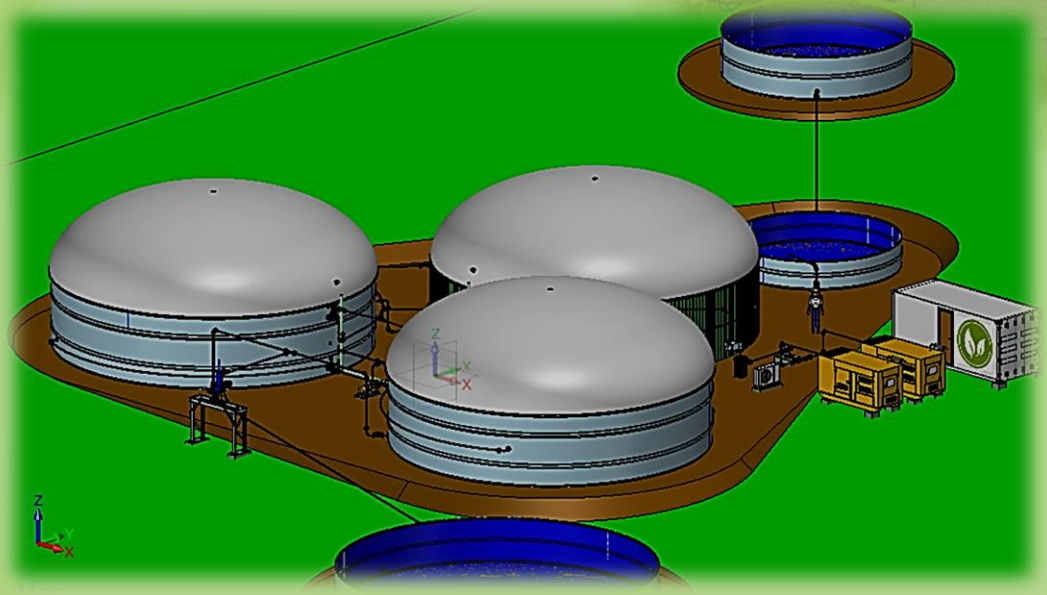
AD Physical Plant



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Potential Feedstock

- Manure (cow, pig, sheep, chicken) – most common feedstock
  - 100 cows ~ 4t manure/day (wet)
  - 480kWh/day
  - 20kW continuous
- Sewage
- Agricultural waste (non-woody)
- Energy crops
- Abattoir waste (rumens, blood, DAF)
- Food processing waste
- Brewery filtrate
- Dairy waste
- Retail food/market/restaurant waste
- Paper pulp

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Feedstock to avoid

- Anti-biotic contamination
- Plastic/packaging
- Bone
- Mineral oils
- Abrasive materials
- Cord/wire/rope
- High-saline waste
- Effluent containing heavy metals

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Advantages of Biogas

- Environmentally acceptable means of organic waste disposal
- Tax-deductible
- Renewable/Sustainable
- Reduces greenhouse gas (CH_4 is 80 times worse than CO_2)
- Reduces load on land-fills
- Uses and re-cycles contaminated water/effluent
- Produces valuable liquid fertiliser (high NPK's)
- Produces clean, friable, non-odorous high-fibre compost substrate/animal bedding

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Cost of Biogas

- Installed cost: R35 000/kW
  - Solar PV ~ R20 000/kW
- BUT
  - 100kW solar ~ 500kWh/day
  - 100kW Biogas ~ 2250kWh/day
  - Easily stored and regulated
  - Low operational costs
- AND
  - Eliminates waste disposal costs
  - Value-added end products
  - CHP
  - “Charge-for” waste disposal service

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Biogas Risks/Cautions

- Living process
  - 100's of bacterial species involved
- Thermophyllic vs Mesophyllic
- Antibiotic/antibacterial contamination
- Organic Overload
- Unstable feed-rate
- Poor temperature control
- Explosion/Fire risk
  - Very low pressure
  - Open-air
  - ATEX equipment
- H_2S

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Why GLOBAL ENERGY?

- Excellent experience in utility and farm-scale biogas
- Exposure to state-of-the-art German tech
- Learnt from others mistakes
- Hands-on engineering involvement
- True local expertise and design
- Local sourcing and product development
- Excellent relationships with government (DEA&DP), NGO’s and waste management services

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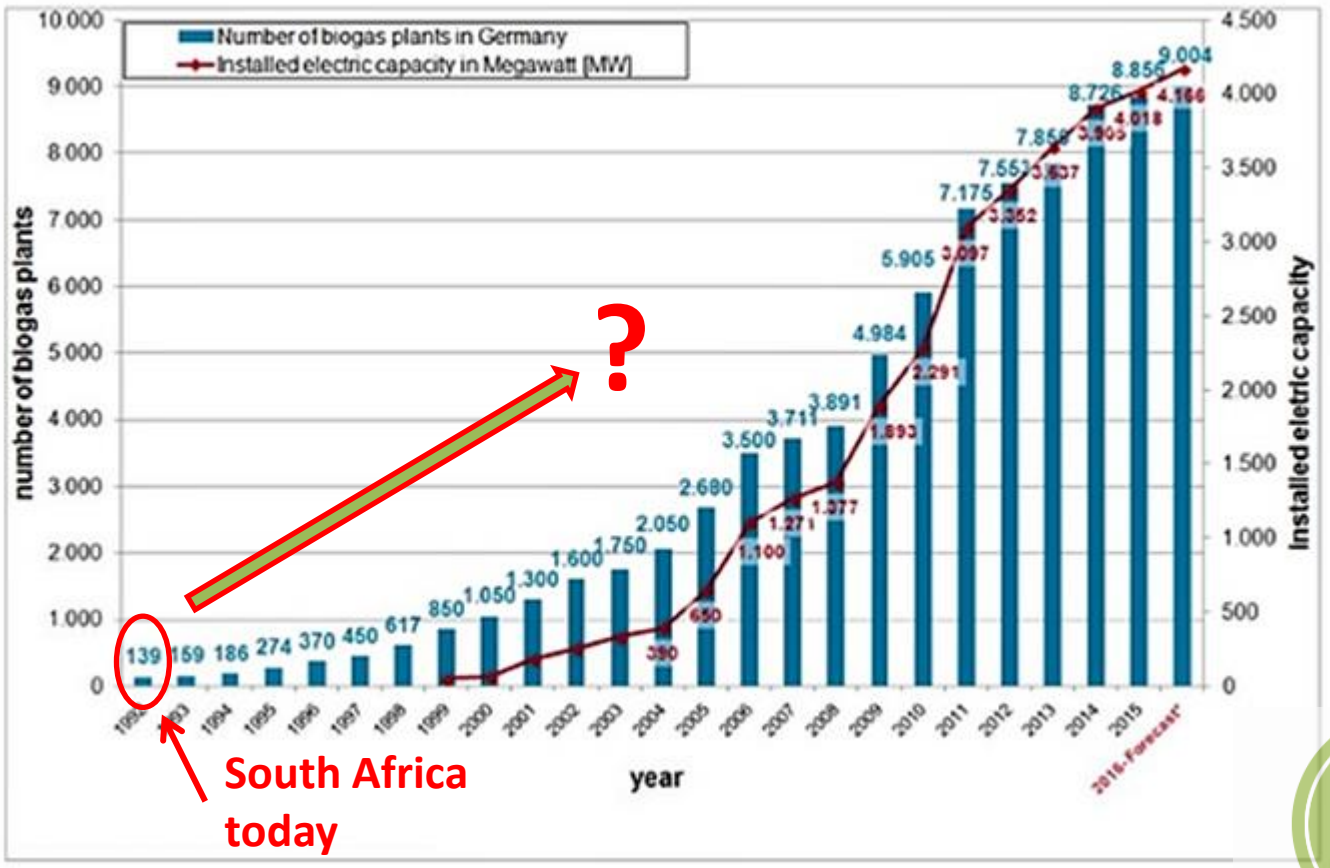
Why GLOBAL ENERGY?



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