
μ2gas: Enhancing Anaerobic Digestion Efficiency and unveiling the Microbial World of Anaerobic Digestion

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Ph.D. Biologist
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Innovative Biomethane Production
Routes in Europe, 19 June 2024



Co-funded by
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innovations in the
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Manthos Panou

Ph.D. Biology focusing in characterisation of cyanobacteria from different habitats

Member of Qlab since May, 2023

- Analyst in microbiological and biological procedures
- Member of Qlab's research grants
- Next Generation Sequencing specialist, Aim to commercialize the NGS analysis for Qlab

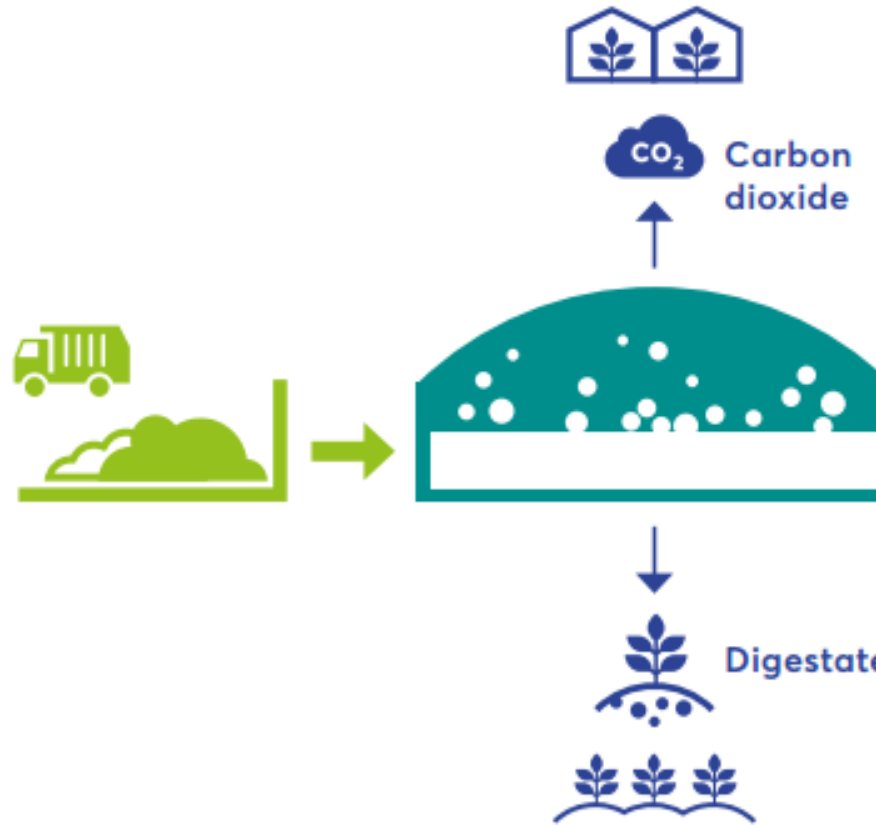
Member of μ2Gas project

Responsibilities:





- Next generation sequencing for the microbiome of biogas plants
- Collection of data for the generation of databases
- CSTR experiments

INPUTS (FEEDSTOCK)

- Energy Crops 
- Plant by-products 
- Animal by-products 
- Biowaste from households 
- Industrial & commercial organic waste 



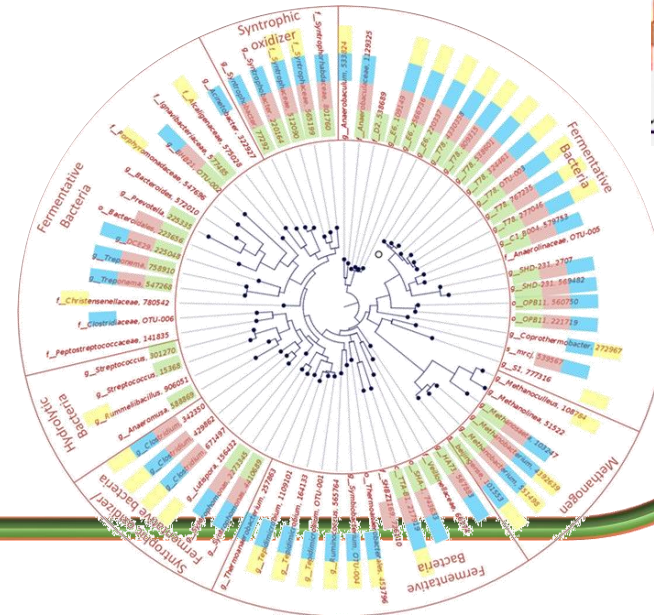
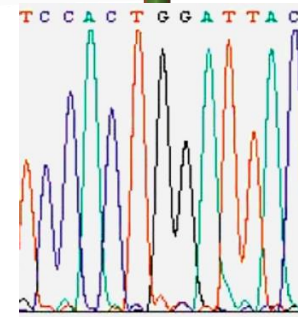
OUTPUTS

-  Biofuel for transport
-  Biomethane injected in natural gas grid
-  Electricity
-  Heat



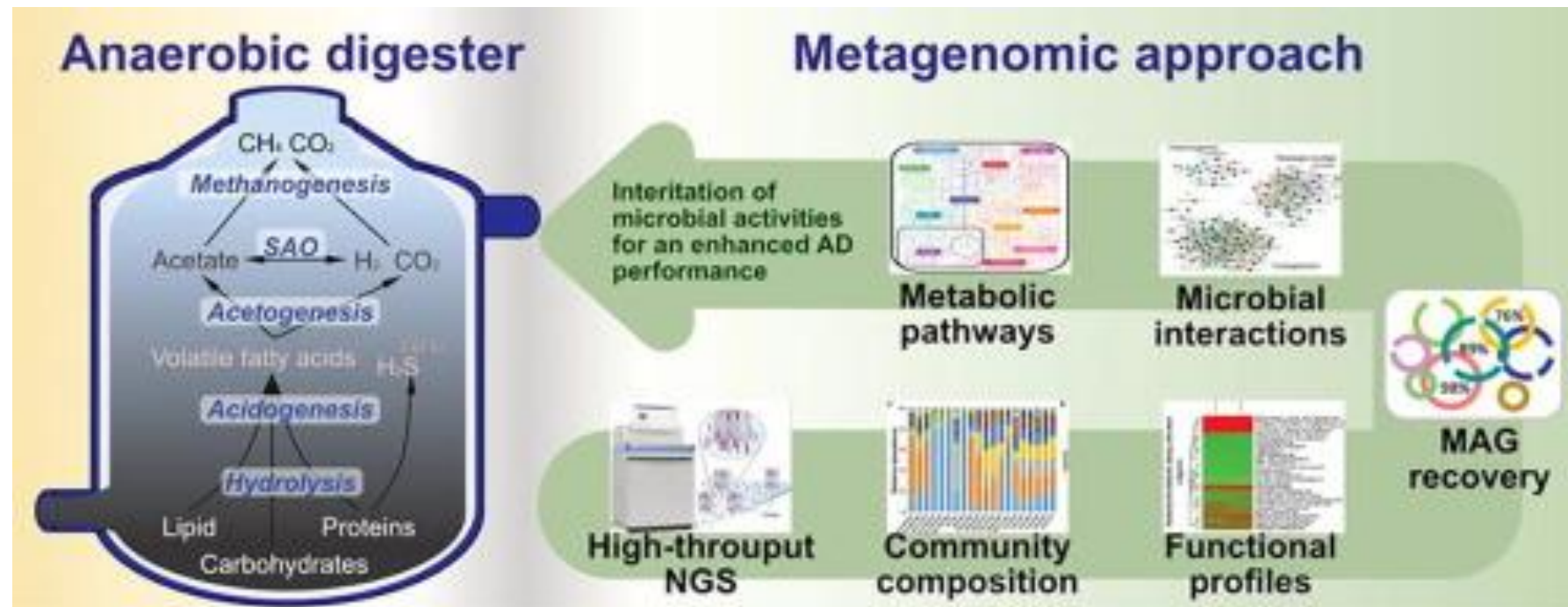
Source: EBA 2020. "Statistical Report of the European Biogas Association 2020."

μ2gas



Operational Management from data of 3 Biogas Plants:

- **Feedstock:** Chemical Composition | Physical Characteristics | Quantity | Feedstock Microorganisms
- **Process Design:** Digester Technology | Digester Operation | Process Microorganisms | Diversity of Biogas Microbiome
- **Diversity of Biogas Microbiome:** Taxonomic | Species Number and Distribution | Functional | Potential and Existing Species Functions | Process Stability and Efficiency | Ecological | Biotic and Abiotic Interactions



Sampling:

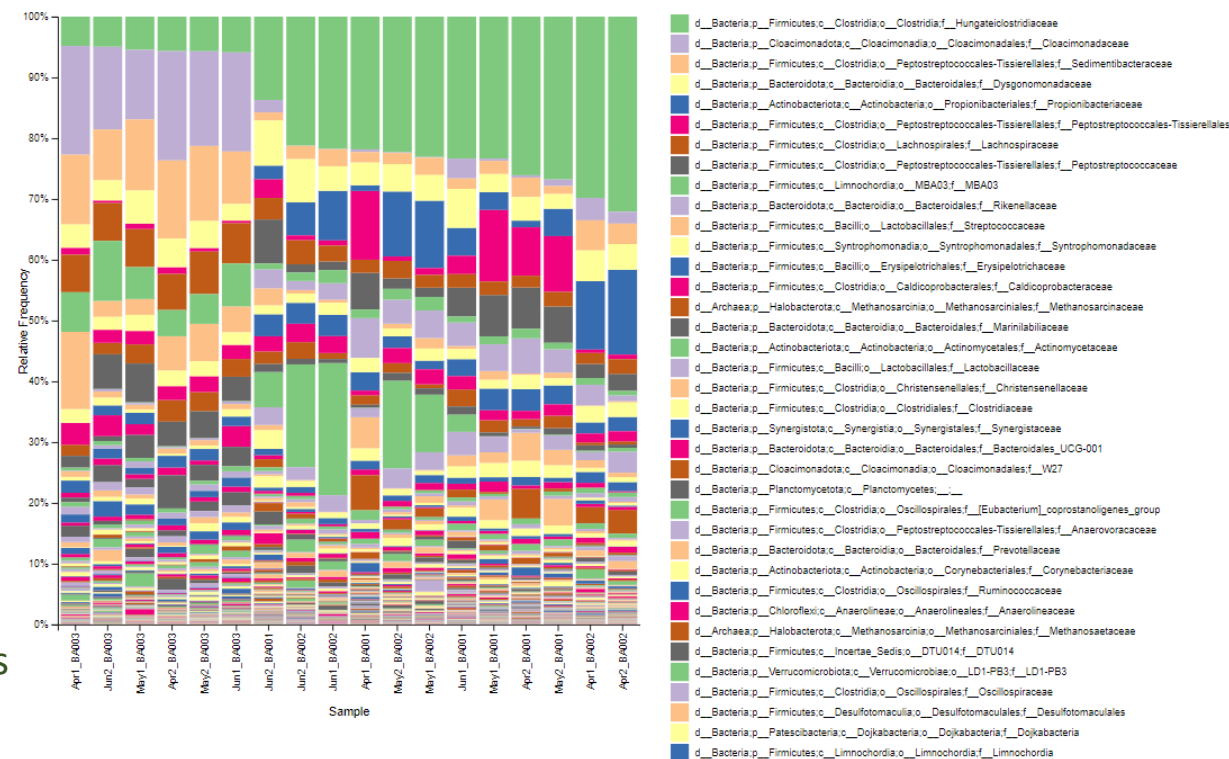
- Collect samples from three different biogas plants
- Ensure consistent sampling techniques for reliable comparison

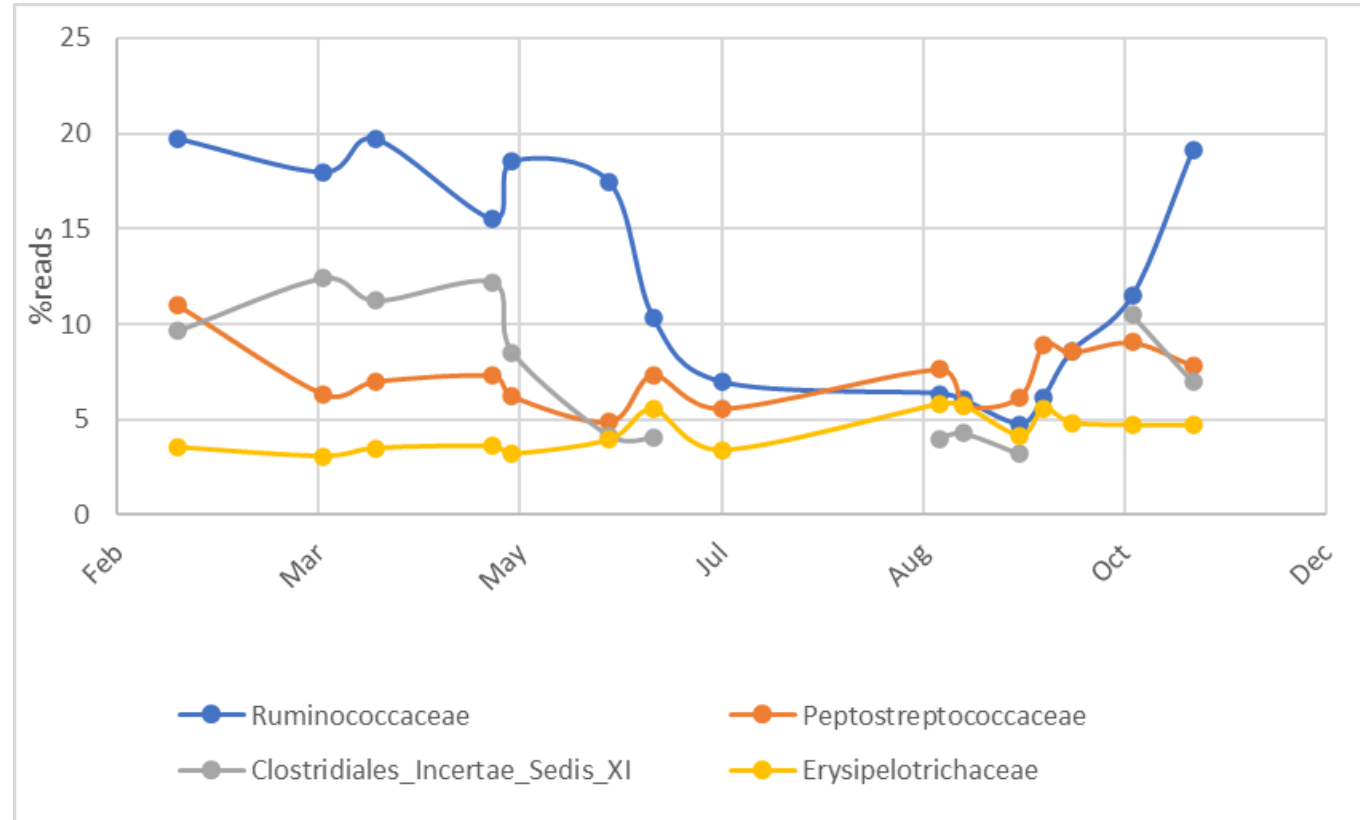
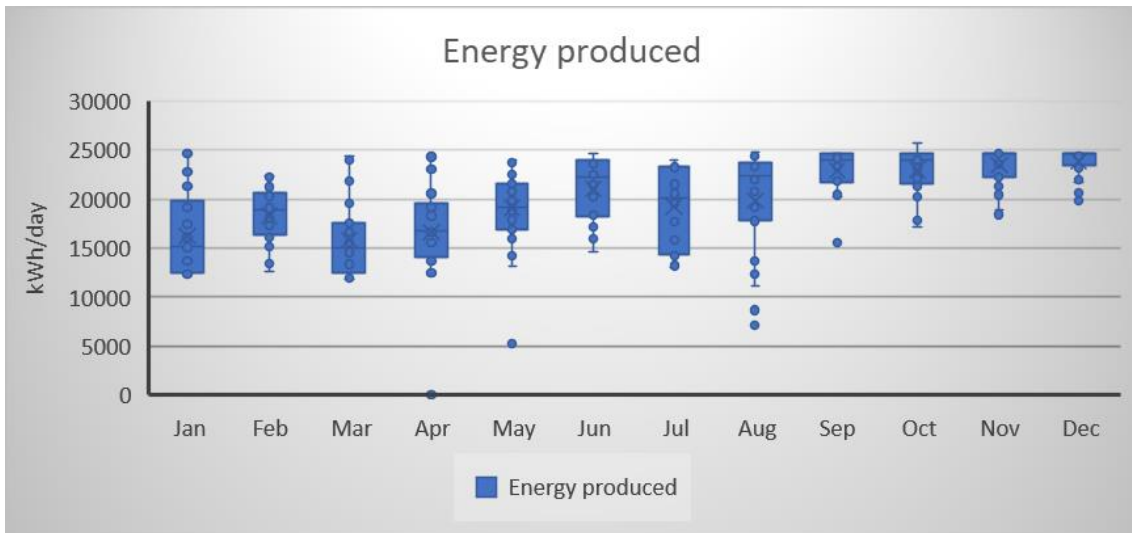
Data Processing:

- Quality control of raw sequence data from 16S rRNA
- Filtering and trimming of low-quality reads
- Clustering of sequences into Operational Taxonomic Units (OTUs)
- Taxonomic assignment of OTUs

Analysis:

- Alpha diversity analysis to assess microbial diversity within each biogas plant
- Beta diversity analysis to compare microbial communities between biogas plants
- Identification of core microbiome and key microbial species





Variation of abundance rates of the four main families during the monitoring period of the unit.

Goal: Verify correlation of functional changes at each stage of the process with microbiome composition and methane yields.



Investigations Include:

- Raw materials
- Operating temperature
- pH
- Free ammonia
- Hydrogen sulphide percentages

Sampling and Sequencing:

- At defined chemical accumulation values
- When an increase or decrease in yields is observed

Further Experiment Design:

- Based on initial knowledge from the Database

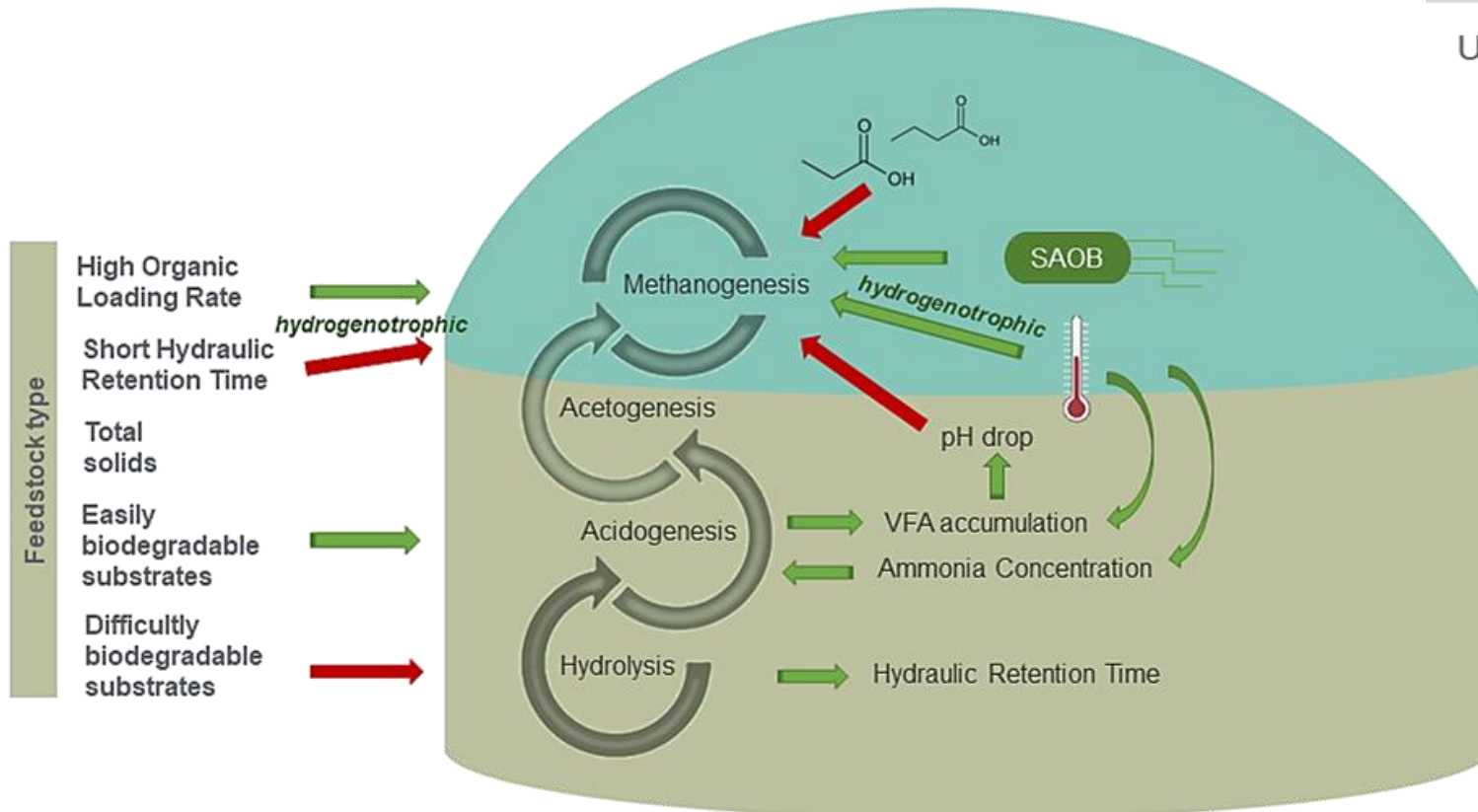
Work Module Aim:

- Find efficient corrective actions in the operation of the anaerobic digestion reactor
- Verify remedial actions in laboratory conditions
- Investigate and identify the relationship between the microbiome and high methane yields

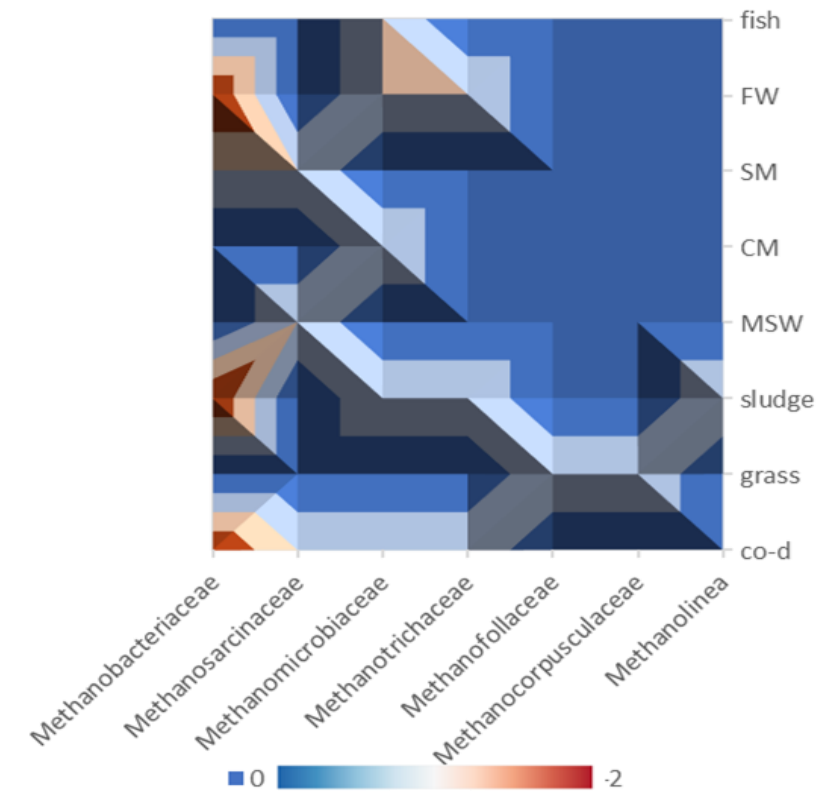
Outcome:

- Develop a commercial service offering next generation sequencing and bioinformatics support to AD system practitioners
- Identify OTUs and key microorganisms in anaerobic digestion
- Correlate key microorganisms with operational interventions
- Develop rapid molecular protocols for detecting key microorganisms for diagnosing interference in biogas plants

Microbial Dynamics in Anaerobic Digestion: A Review of Operational and Environmental Factors Affecting Microbiome Composition and Function (under review)



Upregulated families of Methanogens during different feedstock used



Microbiome-oriented data mining of operational monitoring of anaerobic digestion reactor during steady operation period, failure, and restoration.

Knowledge Discovery in Databases (KDD):

- Process of extracting interesting, previously unknown, and potentially useful information or patterns from data in large databases.

Data Mining:

- Most important step in the KDD process
- Application of data analysis and discovery of algorithms to produce a specific enumeration of patterns in the data

Stages of Knowledge Discovery:

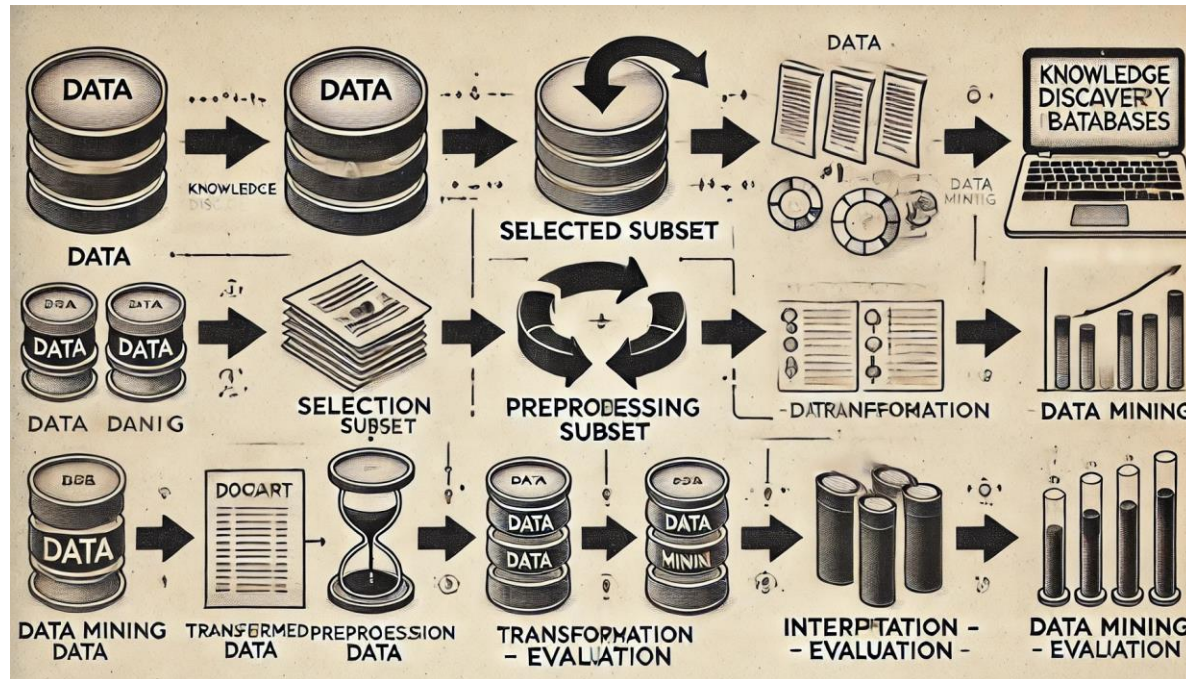
- Data Selection

Data Preprocessing:

- Handling incomplete data, empty fields, and other anomalies
- Also known as the data cleaning stage

Selection of an Algorithm and Application:

- Determining the type of knowledge to be sought
- Choosing the appropriate category of algorithm
- Derivatives of the knowledge discovery process include information patterns - informative patterns





Thank You



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