

Future Water Research and Innovation Needs

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Empowering people to save environment

Outline

- ◆ Recent advances
- ◆ Current issues
- ◆ Future research / innovation needs

Recent advances in water sector

◆ Domestic market

- Disinfection with UV (domestic)
- Membrane filtration (domestic)
- Full process train of advanced treatments (domestic)



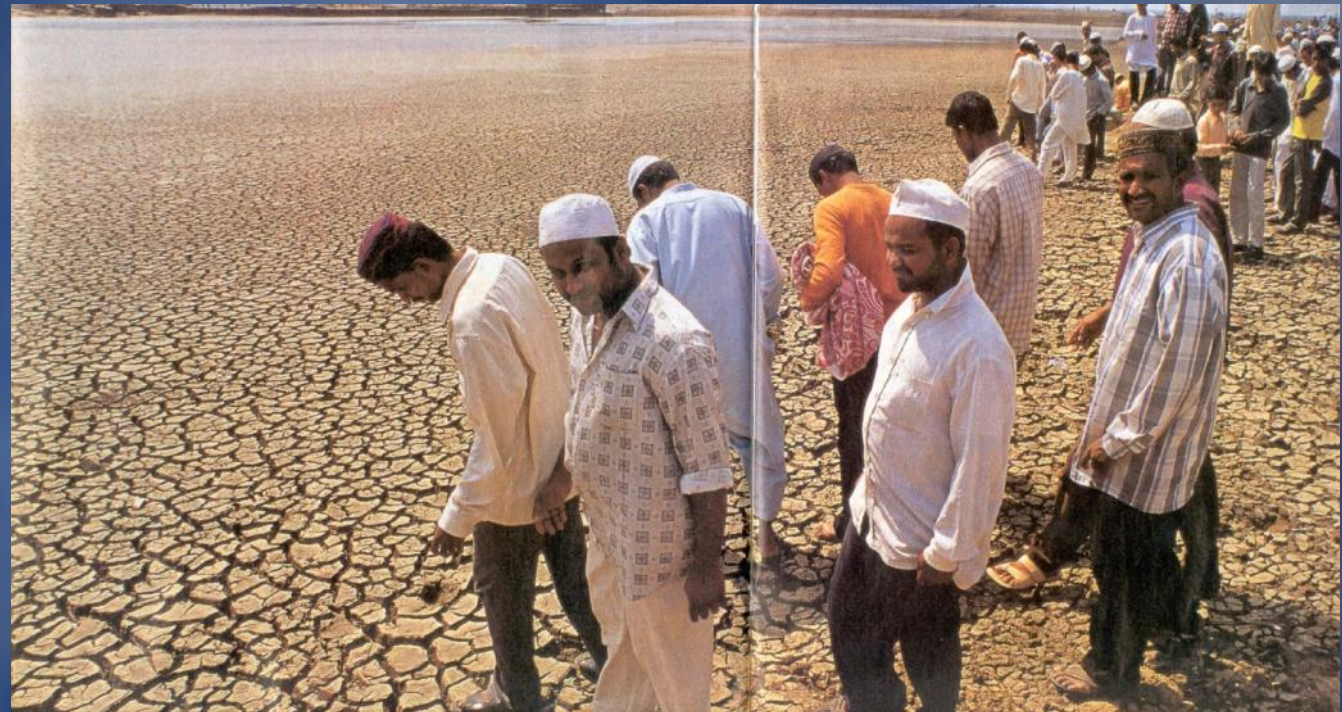
◆ Municipal market

- DAF / sedimentation
- Membrane filters / sand filtration
- Ozone / chlorine



Current issues

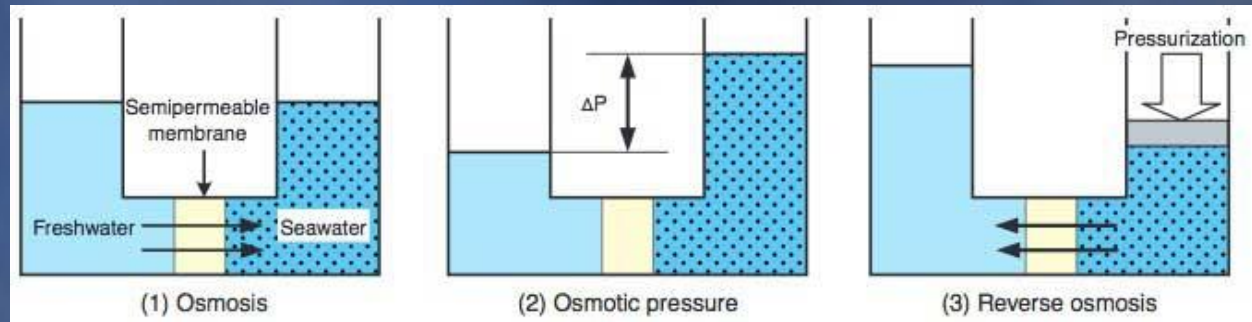
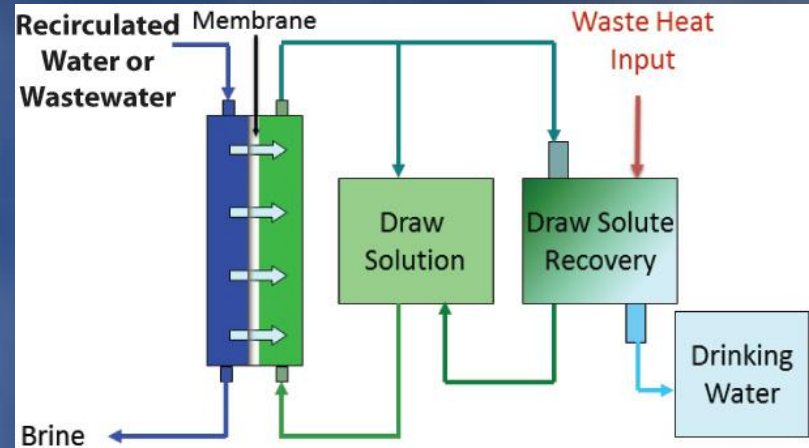
- ◆ Water availability
- ◆ Water quality (arsenic, pesticides)
- ◆ Climate change



Need for innovation

◆ Forward osmosis

- Low cost membranes
- Reverse solute flux
- Low cost energy



◆ Portable purifiers

- Better marketing



Recent advances in wastewater sector

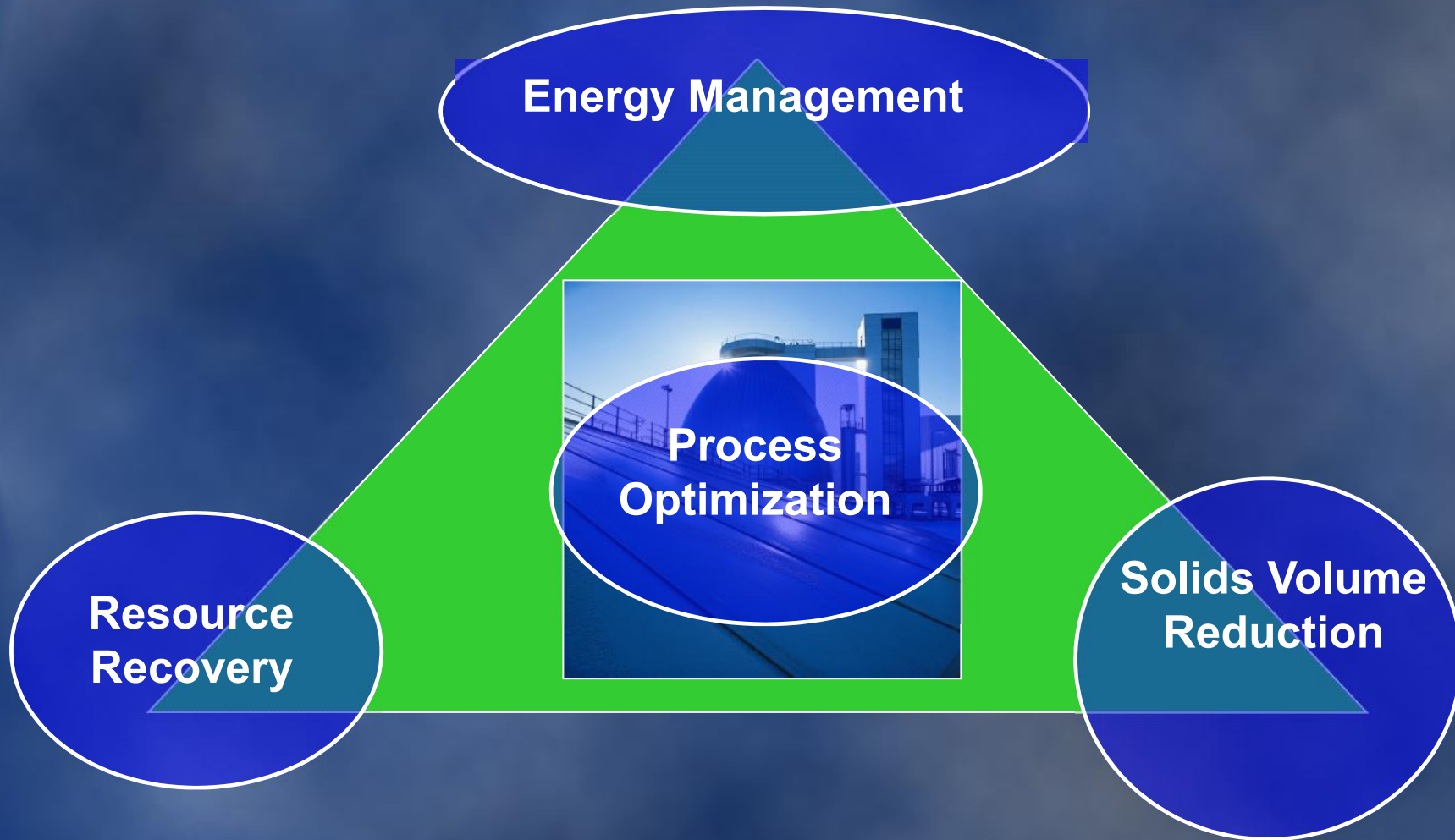
◆ Domestic market

- Growing market due to reuse requirements
- Simple filtration

◆ Municipal market

- Membrane bioreactor
- Combined processes (MBBR / IFAS)
- Nutrient removal (N & P)
- Thermal hydrolysis of sludge
- Wastewater recycle and reuse (NEWater)

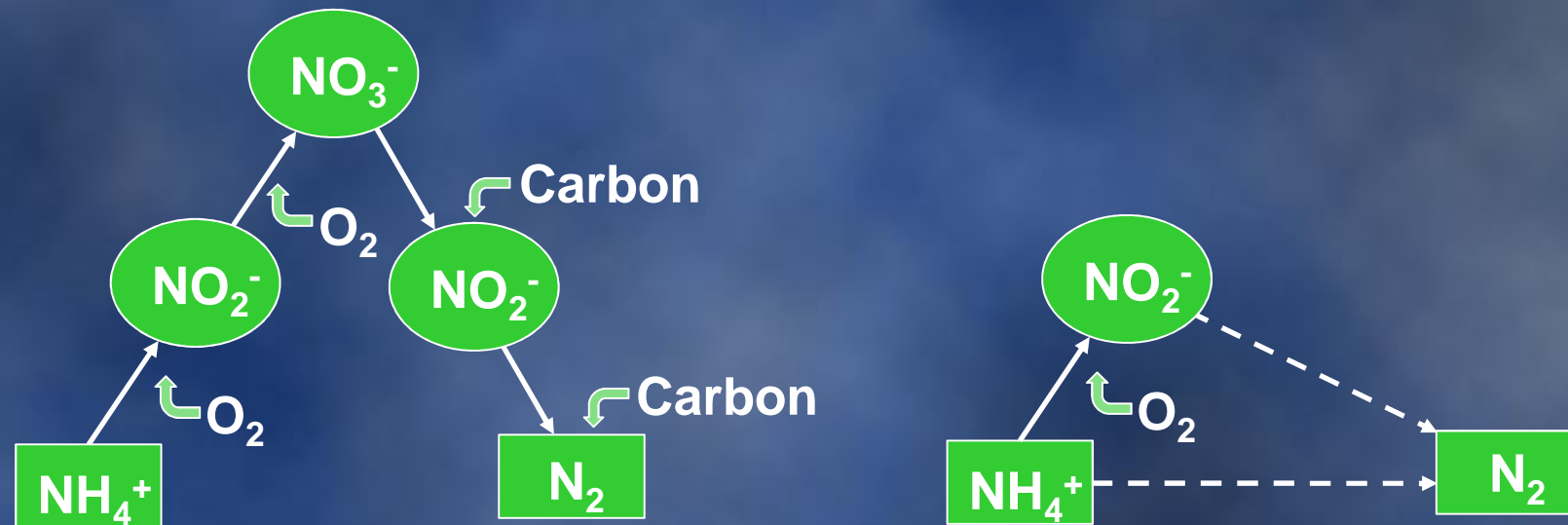
Current issues



Innovations for sustainability

- ◆ Business Sustainability
- ◆ 4R – Recycle, Reuse, Reduce, Resource Recovery
- ◆ Energy Efficiency
- ◆ Process Automation
- ◆ Zero Liquid discharge
- ◆ Concept of Zero-Energy Sewage Treatment Plants

Innovation needs – Mainstream Anammox



- 63% reduction in oxygen
- No supplemental carbon for de-nitrification
- More carbon capture for biogas
- Almost energy neutral wastewater treatment

Innovation needs

◆ Anaerobic membrane bioreactor (An-MBR)

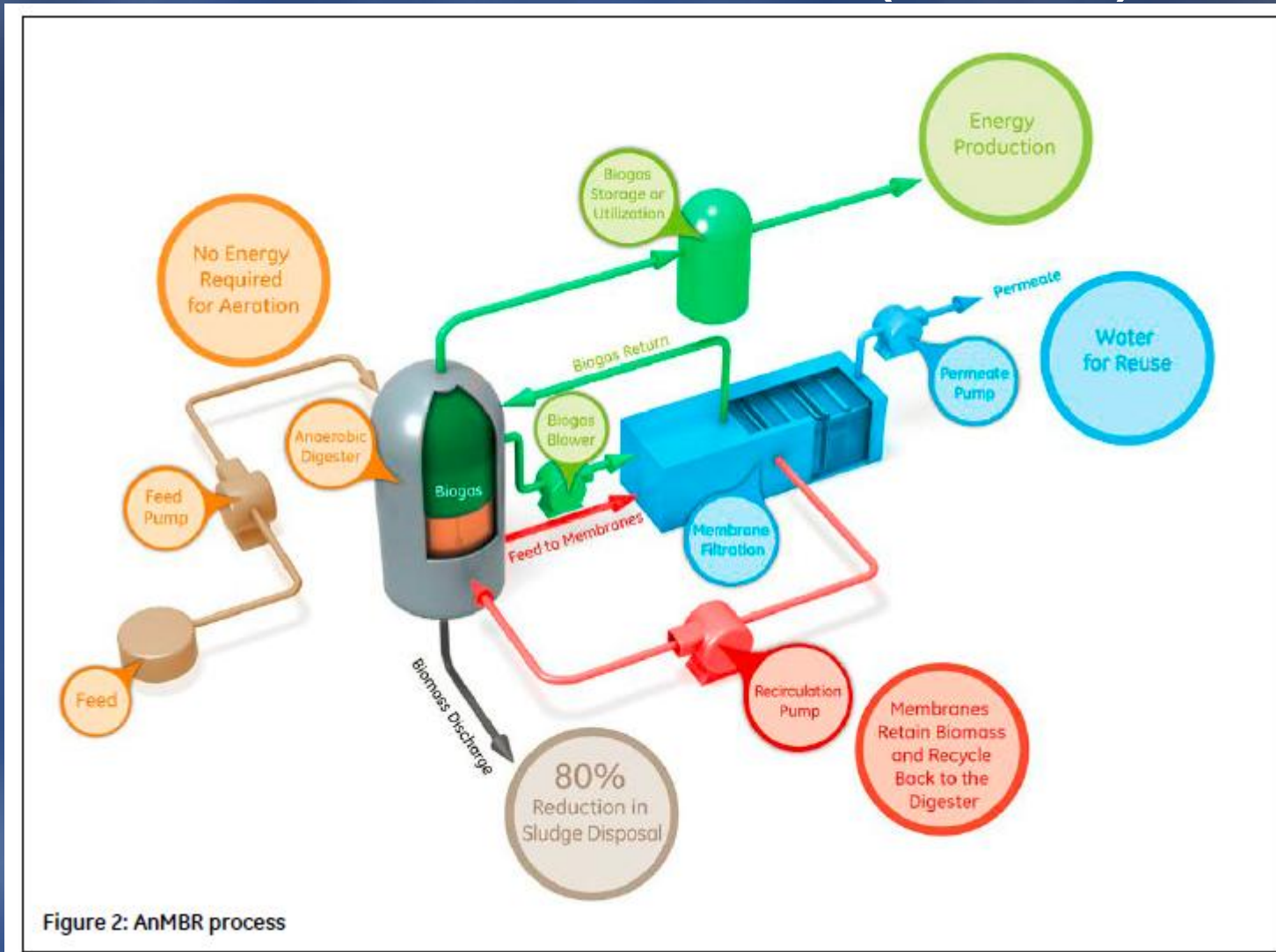
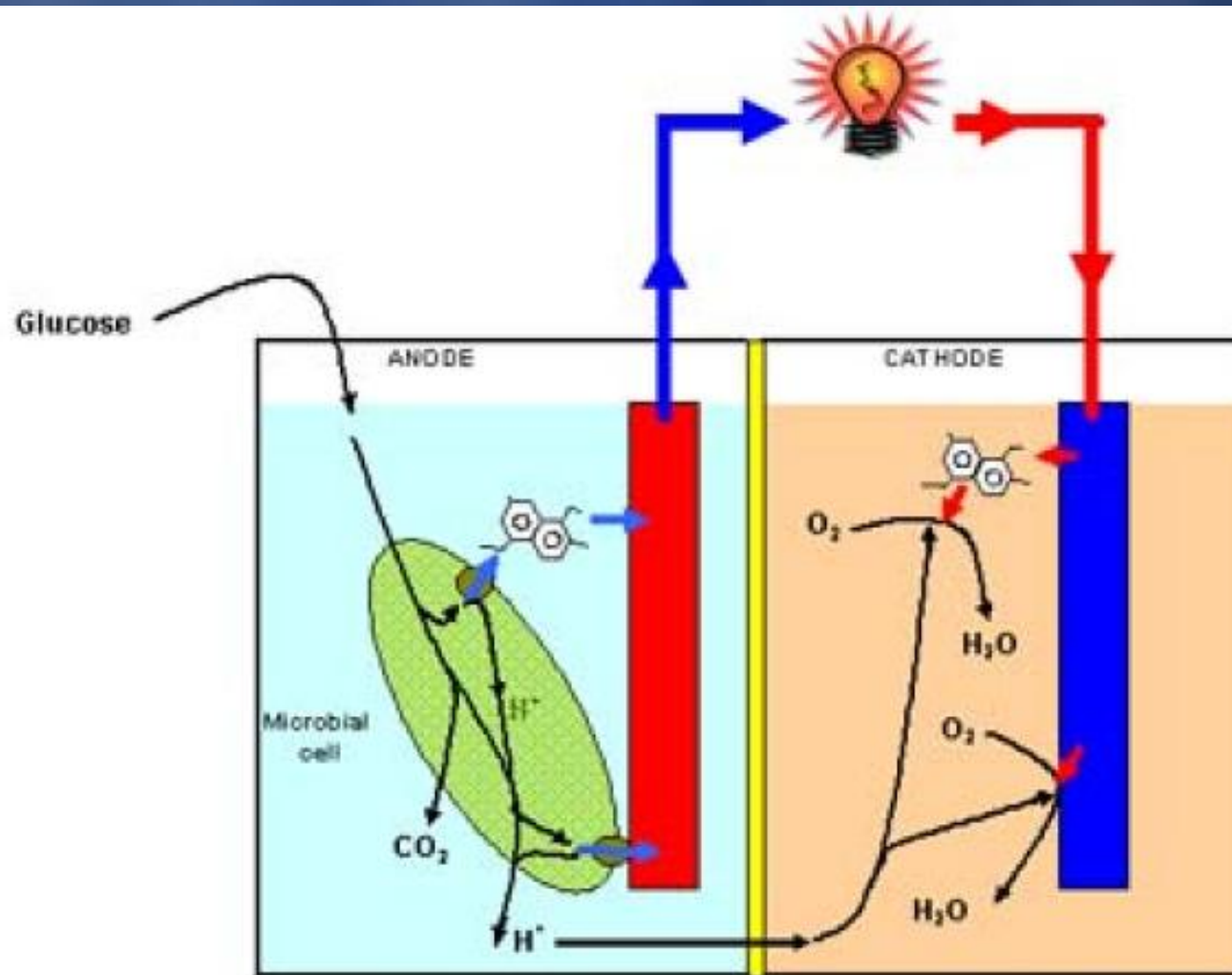


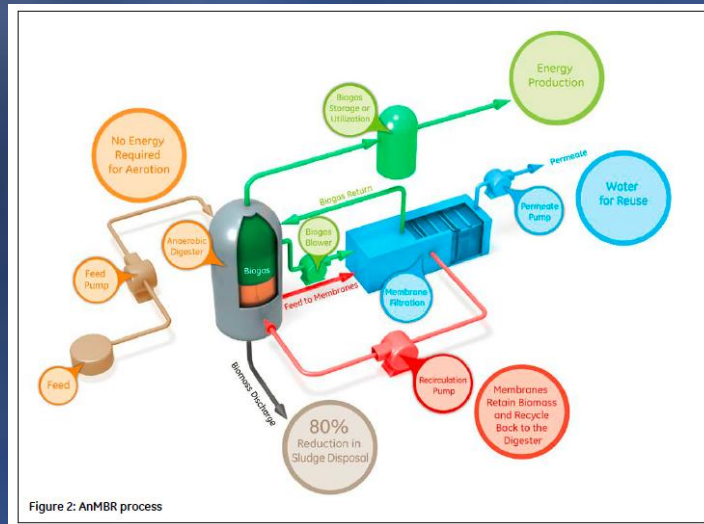
Figure 2: AnMBR process

Microbial Fuel Cell

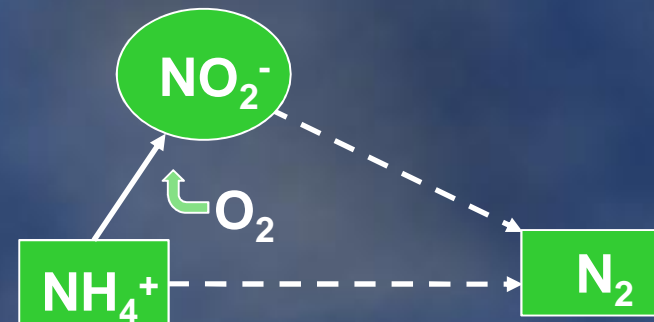
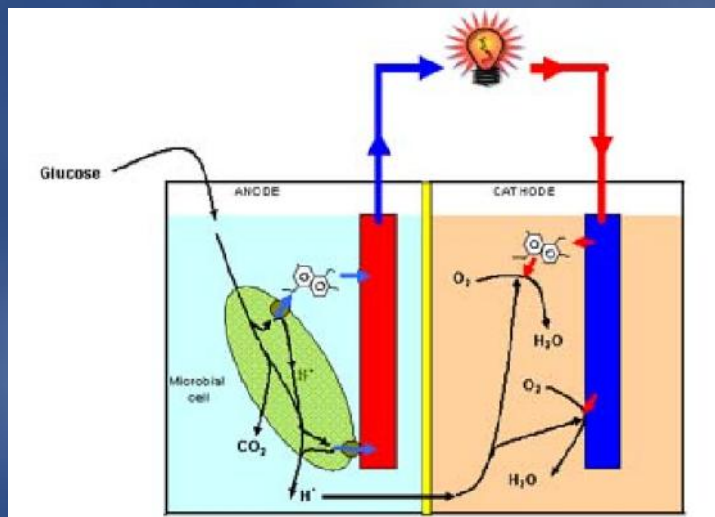


The operating principles of a microbial fuel cell. Electrons can flow to the anode via chemical mediators (upper blue path) or directly (lower blue path). Courtesy of Korneel Rabaey.

Reduce, Recycle, Resource Recovery



- Electricity from fuel cell to power Anammox
- Anammox to remove nitrogen from An-MBR
- An-MBR to capture carbon in biogas for power generation
- Struvite production for phosphorous recovery
- Minimize solids disposal



Other areas for innovation

◆ Sludge minimization

- Cell lysis – sonication, OpenCel
- Cannibal process – predation

◆ Low space requirement

- Ballasted sedimentation
- Ultra fine screens

◆ Energy efficiency

- Ultra fine bubble diffusers
- Critical oxygen point control

Few quotes from Albert Einstein

- **Look deeply into nature, and then you will understand everything better**
 - Anammox
 - Cannibal process
- **We cannot solve our problems with the same thinking we used when we created them**
 - Fuel cell
 - Decentralized treatment systems
 - Critical oxygen point control

Acknowledgements and references

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- Yale University publications

Thank You

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