Resource recovery from industrial wastewater

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Doing more with less

- In 2030 "same business as usual"
  - ~30-40% of earth under water stress
    - ✓*>1.8 bilbion peoples*
  - 1 billion more people to feed
    - ✓*with 60% of water stress available*
- Fundamental challenge "more with less"
  - Actual limits
    - ✓*Governance*
    - ✓*Solve new problems with old solutions*
- What technological developments?
  - For which valorization?
  1) **Water reuse**
  2) **Resources valorization**
  3) **Energy recovery**

From treatment to valorization

FROM WWTP TO WRRF

Treated water

2) Energy valorization
Biogas production
Heat recovery/production

1) Impact reduction
Ensure treatment
Reduce energy consumption
Reduce (CO_2, N_2O, CH_4)

3) Resource valorization
Water (Irrigation, Industries)
N-P-K / Metals
Bio-Plastics…

4) Digital Innovations
Captors
Control strategy

Wastewater

Which strategies to apply 3 R rules???

Today

WW = pollutants

Energy
O_2
chemicals

Sludge
waste

Activated sludge
Conso.~ 0,6 kwh/m^3

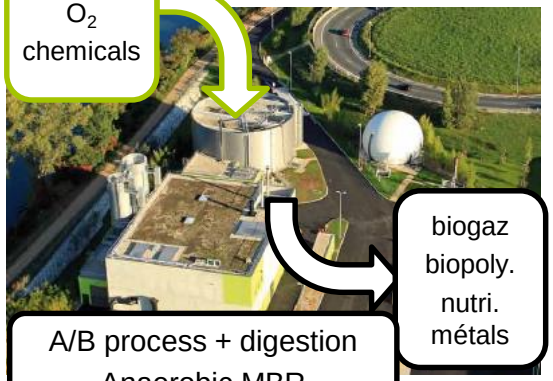
Treated WW

+ control O_2 (Reduce GHG, reduce E)
+advance desinfection (Reuse)
+A. digestion (Recovery E 30%)

Tomorrow

WW = ressource

Energy
O_2
chemicals



biogaz
biopoly.
nutri.
métals

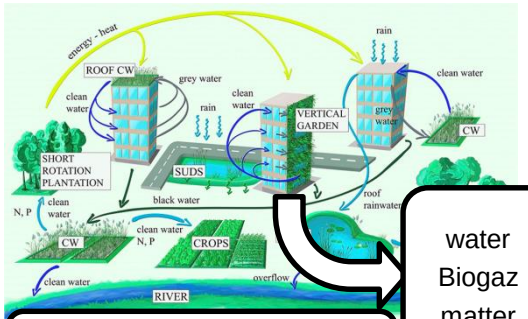
A/B process + digestion
Anaerobic MBR

Treated WW

+proc. A et B Reduce E (0), C
+advance desinfection (Reuse)
+production CH_4 N-P digestats
(Recovery E 40-50 %)

Day after To.

Urines, Fèces,
organic matter, grey
water



water
Biogaz
matter

Water segregation
Micro méthanisation, NBS

Eaux, biogaz,
nutriments, compost

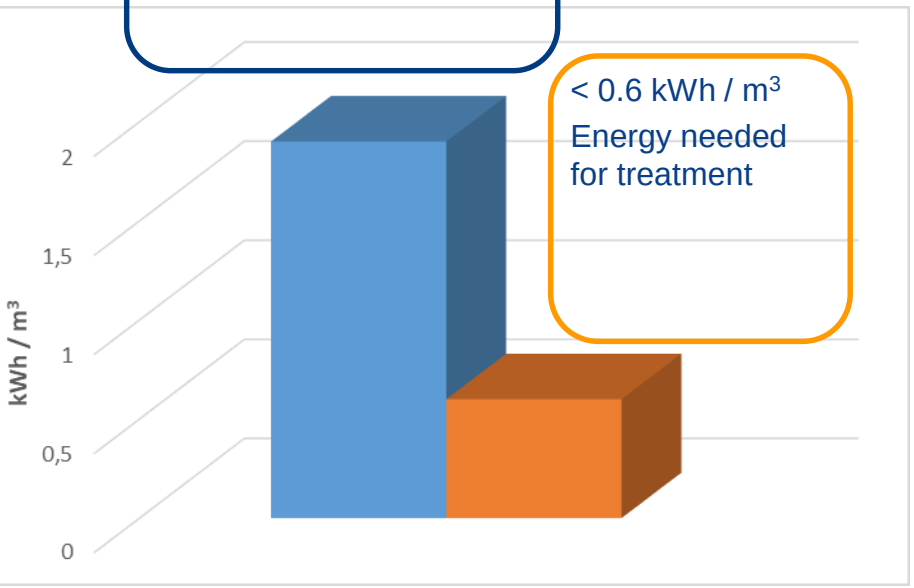
+harvest rainwater (Reduce E)
+desinfection grey water (Reuse)
+CH_4 N-P digestats (Recovery)

Water energy-nexus

Water needs energy, energy needs water

1.9 kWh / m³
Potential energy in WW

< 0.6 kWh / m³
Energy needed for treatment



Domestic WW contains 4 to 5 times energy required for their treatment

Industrial WW up to 1000 times!

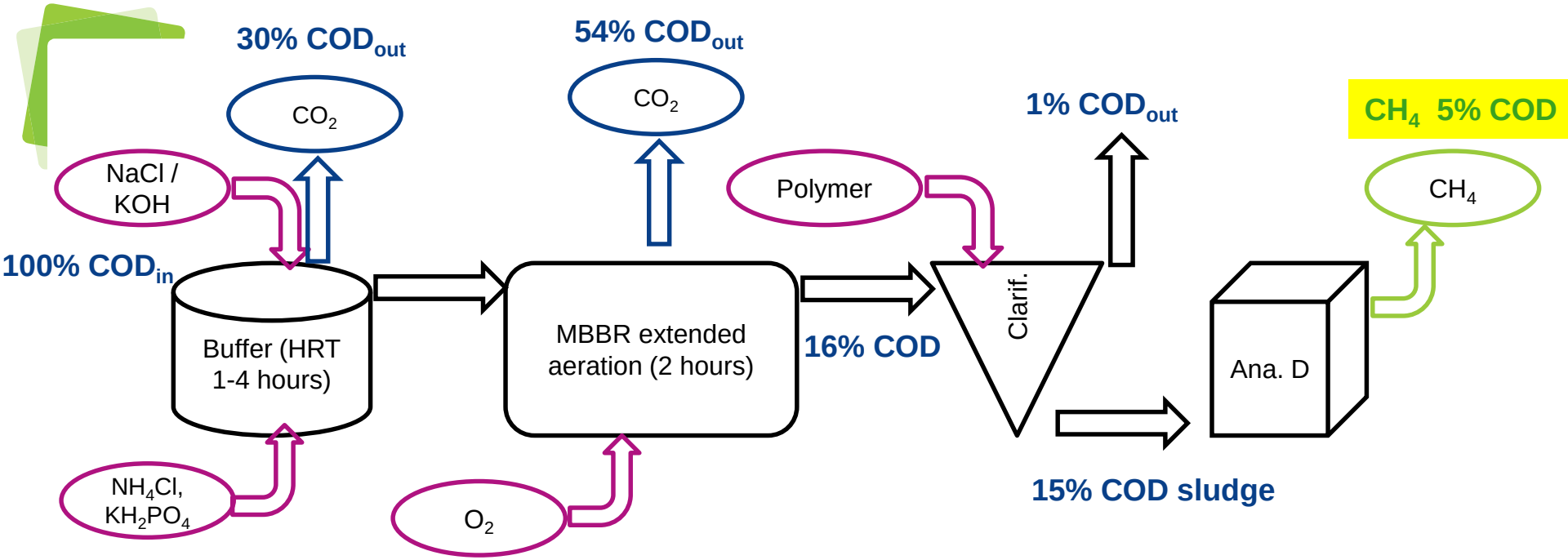
Ref: Batstone et al., 2015
Source: techalive.mtu.edu/

3) Energy recovery

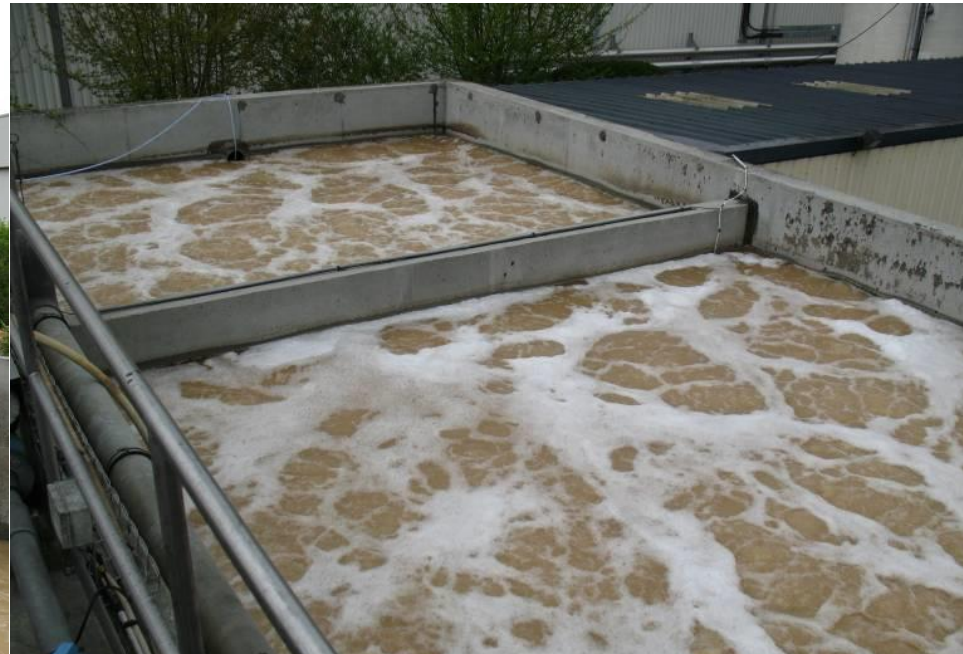
- Redirect…
  - **Heat flow in sewer systems (if no impact)**
  - **Harvest rather than oxidize C, valo by CH_4**
    - ✓*Reduce injection O_2 / limit C available for Denitrification*
- Low energy Nitrogen treatment
  - **Anammox, Nitrate shunt, .**
- Strategy : using existing infrastructure to achieve it
  - **Change biological reactors / restructure**
    - ✓*Turn extended aeration in HRAS (A process)*
  - **While maintaining discards limits!!!**

Case study of a soda factory (simulation)

- Existing plant : 200 m^3/d - 5d/week
  - **COD in 8 – 16 g/L, with varying pH 5-12, T°=30°C**
  - **COD out <125 mg/L**
- Infrastructure
  - **Buffer tank**
    - ✓ *For pH control (7)*
    - ✓*Nutrients deficient (target C/N/P =100:5:1)*
  - **MBBR (moving bed biofilm reactor)**
    - ✓*Keep biomass during weekends – good sludge quality*
  - **Clarifier (+ polymers) + Belt filtration**
  - **Anaerobic Digester**

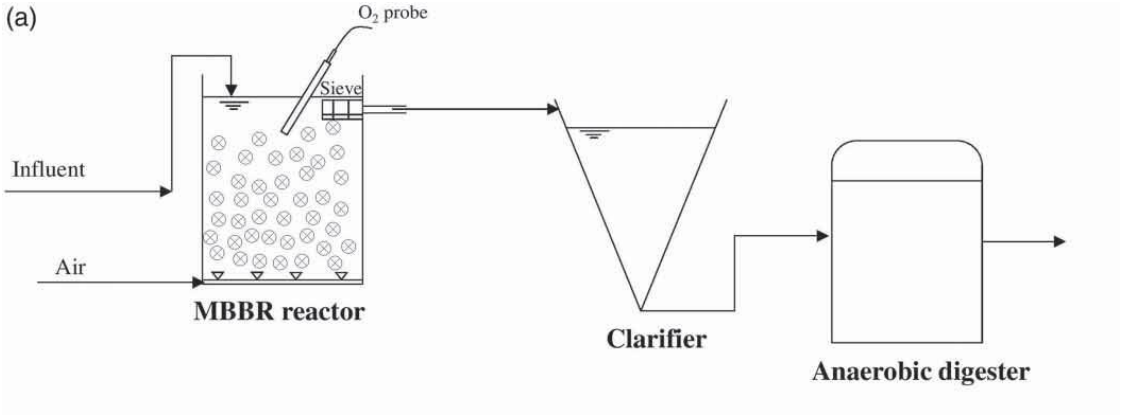


200 m^3/d with ~12 gCOD/L = 2400 kg COD/d



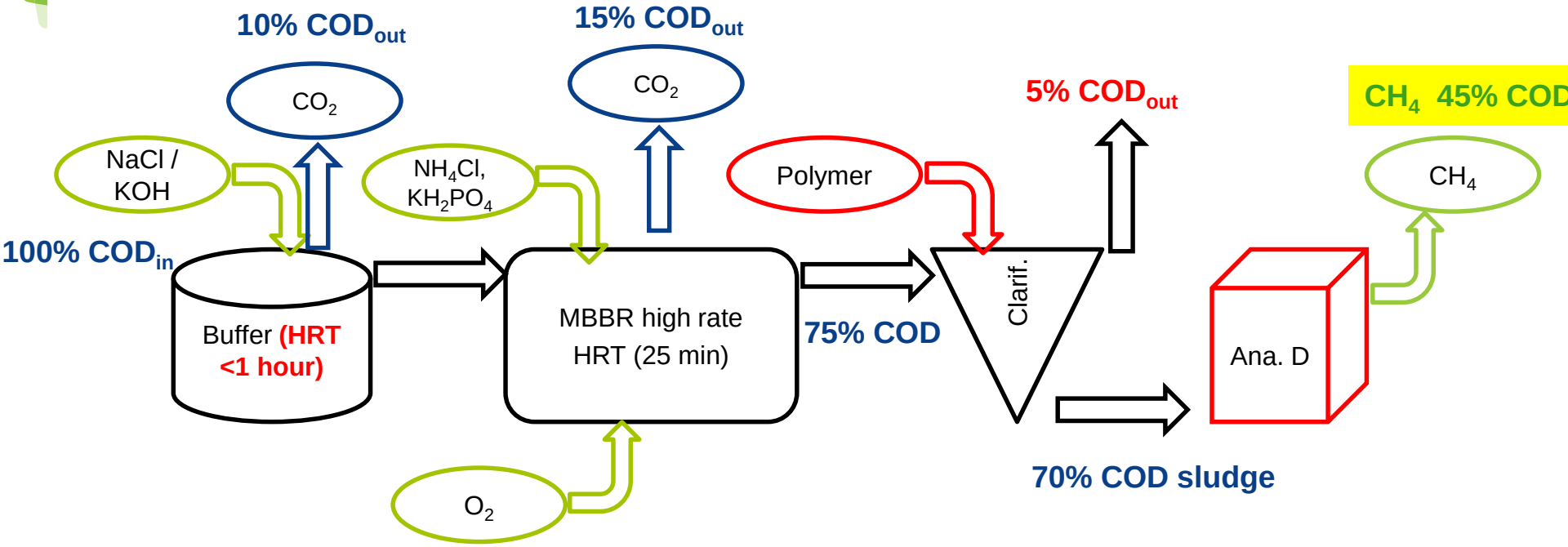
Pilot scale trials under field conditions

➢MBBR study, best Operating Parameters



- **Maximize COD in Mix liquor**
  - ✓*Reduce mineralization*
  - ✓*Maintain treatment*
- **DO, HRT, BMP**

Proposed change



- Objectives less Chemicals : pH control, N/P…
  - **O_2 reduced by 10!!!! (22kg/d to less than 2kg/d)**
- System update
  - **Tertiary treatment needed 600 to 125 mg COD/L**
  - **More polymer + Double volume capacity of AD**

Conclusions

- Increasing interest in valorization
  - **Solutions without extreme infrastructure costs exists**
    - ✓*For Carbon recovery, nutrients, also for water re-use*
    - ✓*Tailored to each industry*
- Potential market is huge
  - **CAPEX and OPEX simulations**
  - **LCA, carbon footprint, water footprint…**
  - **Mature technologies can be implemented**
- Research needed
  - **Produce valuable molecules (PHA, VfA)**
  - **Include resource recovery in circular economy…**

Thanks

- Questions?