ATV: Gå hjem!

Full-scale solution and cost estimation of MBBR with a biofilter

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Tiago Carvalho

TARH – Terra, Ambiente e Recursos Hídricos, Lda

(Earth, Environment and Water Resources)

Tiago.carvalho@tarh.pt

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UP water

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Agenda

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- Welcome
- Introduction to subject and project
- Moving bed biofilms reactor in combination with a biofilter – basic design considerations and removal rates in the CS Stengården pilot
- Full-scale solution and cost estimation of MBBR with a biofilter
- Biochar based constructed wetland – design and removal rates in the CS Besòs
- Decision support tool for choosing between treatment options: method, criteria and criteria weighting

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Upscaling

Why?

- Ensure project **continuity beyond pilot phase** – aim for **long-lasting impacts** 🌱
- Assess **replication** potential in other regions – Adaptable solutions, possible to transfer to other areas 🌍
- **Bridge the gap between science and industry** – Facilitate collaboration with commercial and industrial stakeholders for broader adoption. 🤝
- Provide insight for **decision-making and water management** 💡

How?

- Identification of **key indicators** at the test site: Hydraulic loads, Retention time, Removal efficiency, Energy needs
- **Sensitivity analysis** at pilot and larger scale for some key variables: Water quality, flow rates, solution configuration, substrate thickness
- Identification of suitable areas for the application of NBS
- **Hydrogeological Modeling** – Assess environmental impacts in the aquifer

Upscaling Considerations

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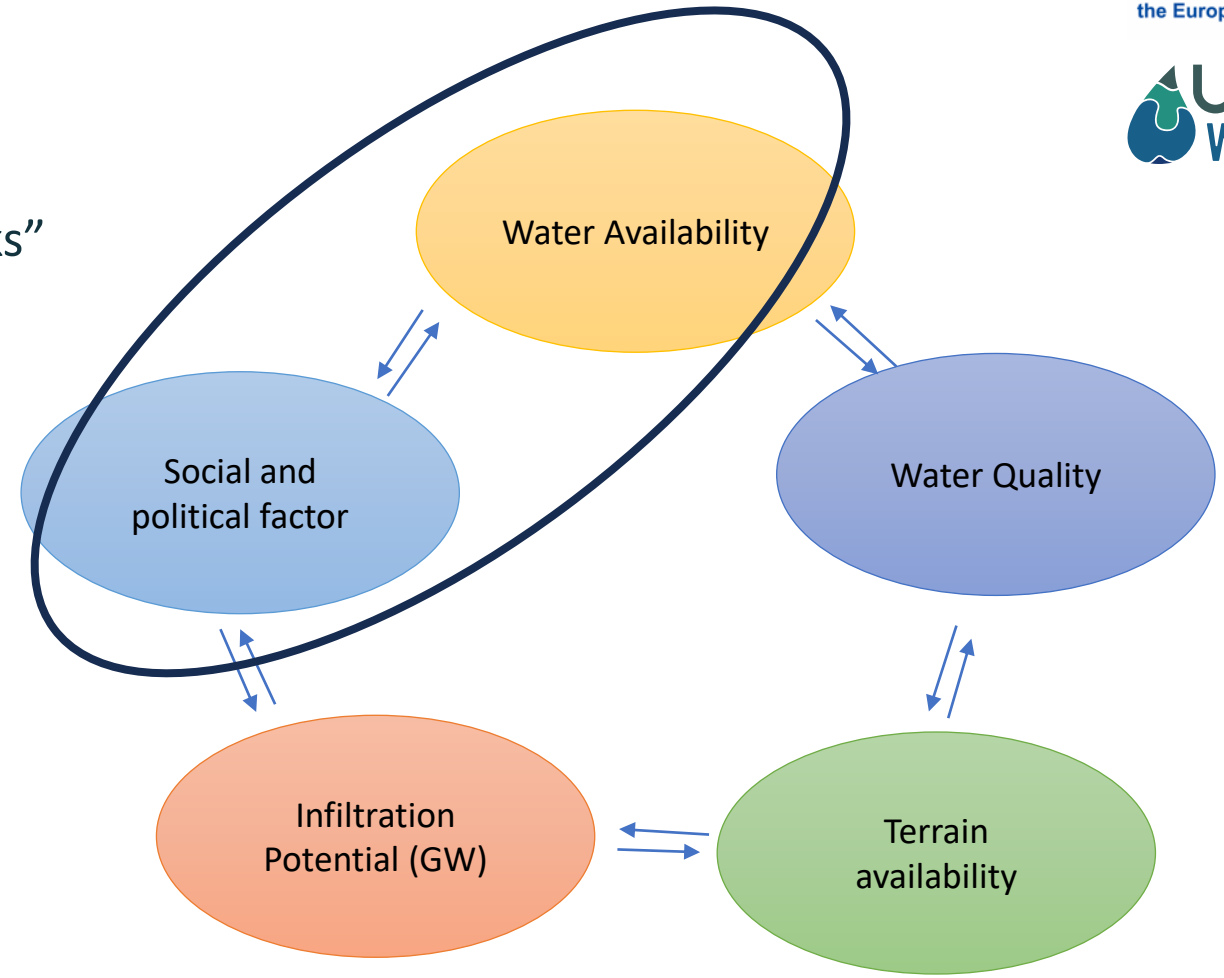
"Expand the benefits, reduce the hazards and risks"

How to size the solution?

- Water availability
- Environmental goals
- Terrain constraints
- Infiltration potential (for MAR projects)
- Social and political willingness



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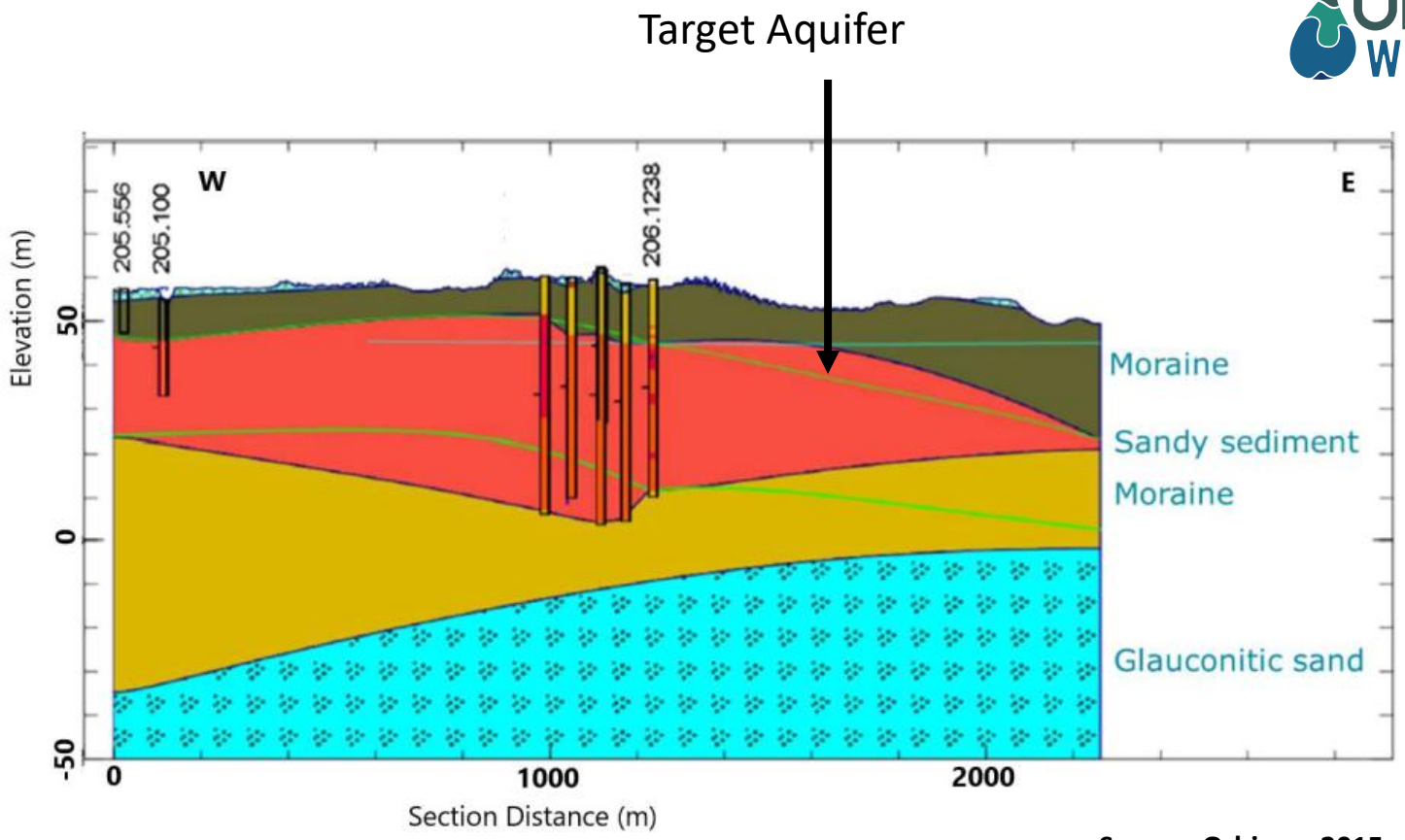
Geology and Hydrogeology

Upper Moraine (Quaternary): 5-10 m thick moraine deposits, mainly composed of silt.

Sandy Sediment (Torkildstrup formation): Meltwater sand and gravel deposits at the edge of the advancing Northeast Ice Sheet. (25-30 m thickness).

Lower Moraine (Quaternary): Varying thickness - average 30 m - mainly clay.

Glauconitic Sand (Lellinge Grensand formation / Paleocene): Marine deposits with a highly variable geological sequence consisting of clay, silt, sand, and limestone - presence of glauconite.



Source: Orbicon, 2015

Geology and Hydrogeology

Regional flow S-N (sometimes SE-NW)
Hydraulic Gradient: 0,003
Average Hydraulic Conductivity: 28,5 m/d

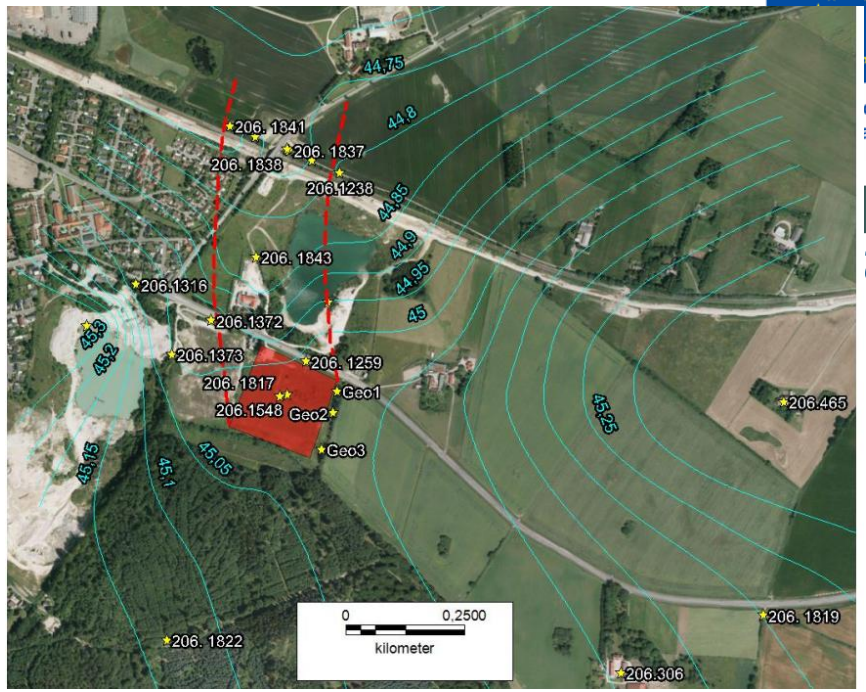
$$Q = -KA\frac{\Delta h}{L} = KiA$$

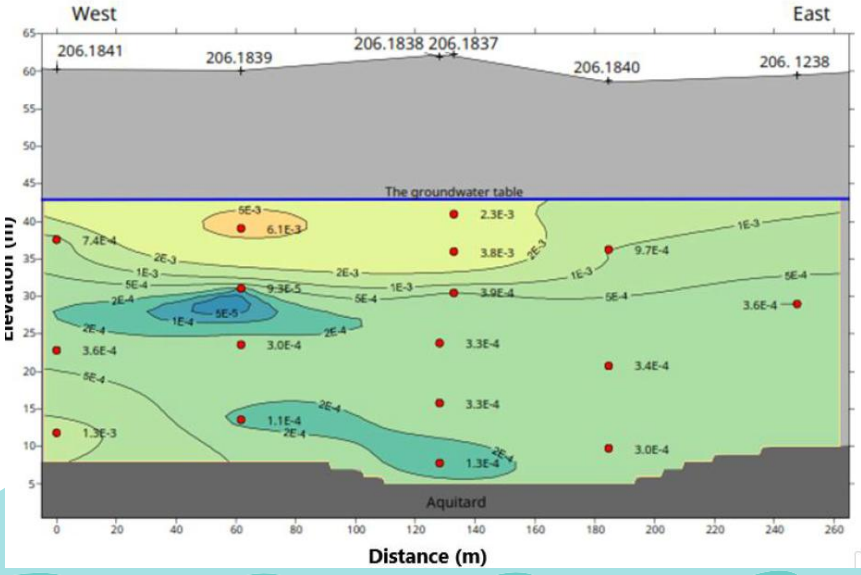
Darcy's Law

Estimated water flow (Width ≈ 125 m): 421 m^3/d (**17,6 m^3/h**)
Estimated water flow transversing the landfill (18 m depth): 192 m^3/h (**8,0 m^3/h**)

Two fully operational wells abstract **10 m^3/h**.

Lake area: 27 000 m^2
Typical infiltration rates in sand: 20 mm/h
Infiltration rate: **540 m^3/h**





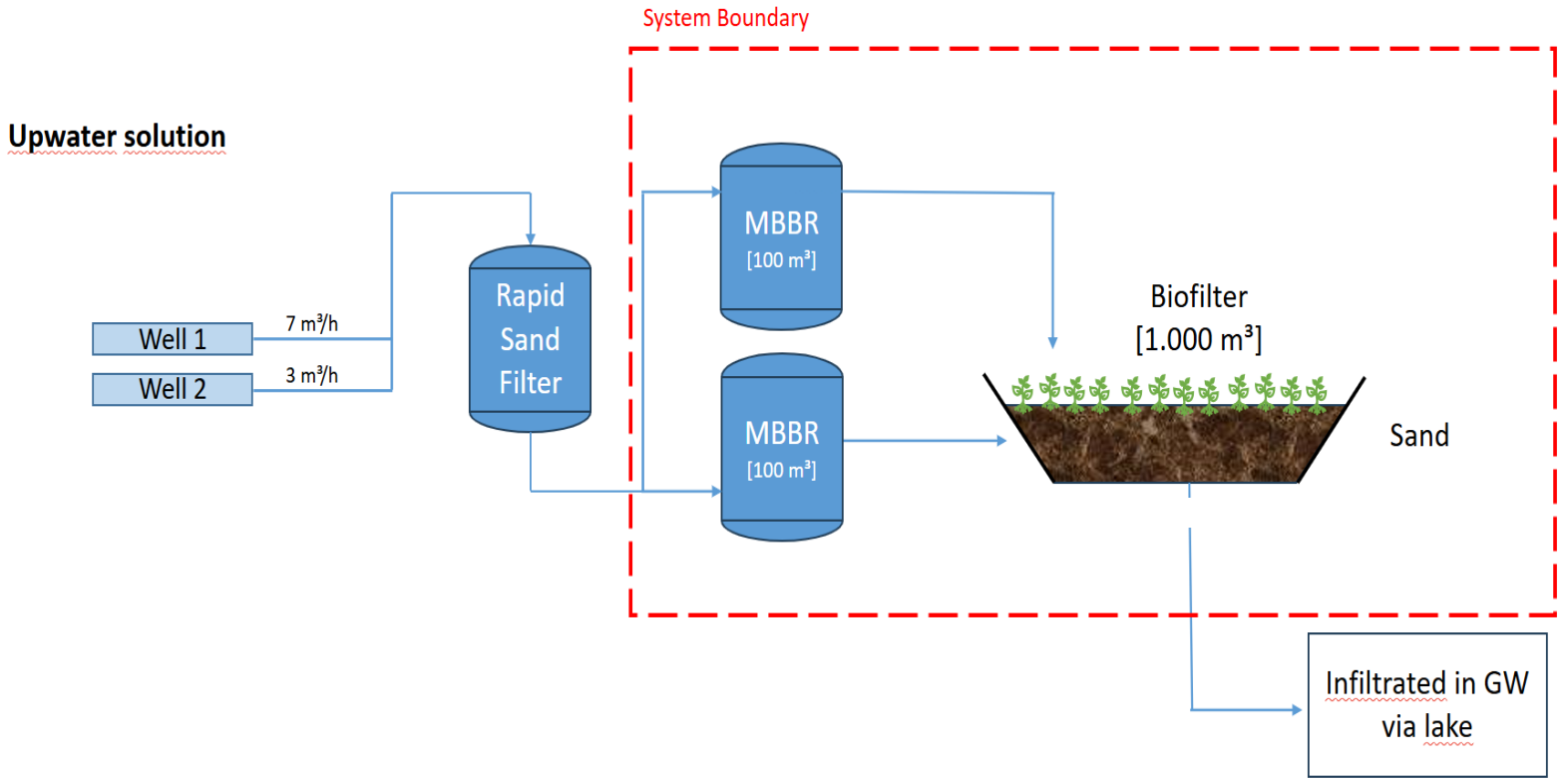
Source: Orbicon, 2015

Upscaling sollution

- Mix of the water from both wells
- Rapid filtration
- MBBR reaction – Partial CECs removal
- Biofilter – Complementary treatment

Key Features:

- Segmentation / Modularization:
  - Maintenance
  - Improve treatment flexibility
  - Accommodate natural bioreactors variability;
- Energy and resource efficiency
  - Preference on gravitational flow
  - Preference on nearby areas



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CAPEX

MBBR reactor: € 334 K
Biofilters: € 179 K
Total: € 513 479 (3 832 779 DKK)

Item	Cost (€)
Concrete Slab	68 551,84 €
Aeration system	8 568,98 €
Carriers	64 267,35 €
Outlet sieves	8 568,98 €
2x Mechanical mixers	25 706,94 €
2x reactor tanks (prefabricated)	68 551,84 €
Bridge for the top-mounted mechanical mixers	29 991,43 €
Pumps	12 853,47 €
2x blowers (give at least 500 Nm^3/h)	29 991,43 €
Piping work	17 137,96 €
TOTAL	**334 190,22 €**

Item	Quantity	unit	Cost (€)	unit	Total
Land Preparation and Escavations					
Land Aquisition	1200	m2	2,31	€/m2	2 772,00 €
Land preparation(modelling)	1320	m2	10	€/m2	13 200,00 €
Earthworks	1452	m3	20	€/m3	29 040,00 €
NBS structure					
HDPE Geomembren	1664	m2	7	€/m2	11 648,00 €
Plants	1200	m2	5,00	€/m2	6 000,00 €
Sand	1200	m3	55,65	€/m3	66 780,00 €
Hydraulic Structures					
DN50	275	m	80	€/m	22 000,00 €
DN50 valve	5	unit	150	€	750,00 €
Air release Valves	2	unit	400	€	800,00 €
Earth Channel	200	m	50	€/m	10 000,00 €
TOTAL					
Project					16 299,00 €
Total					**179 289,00 €**

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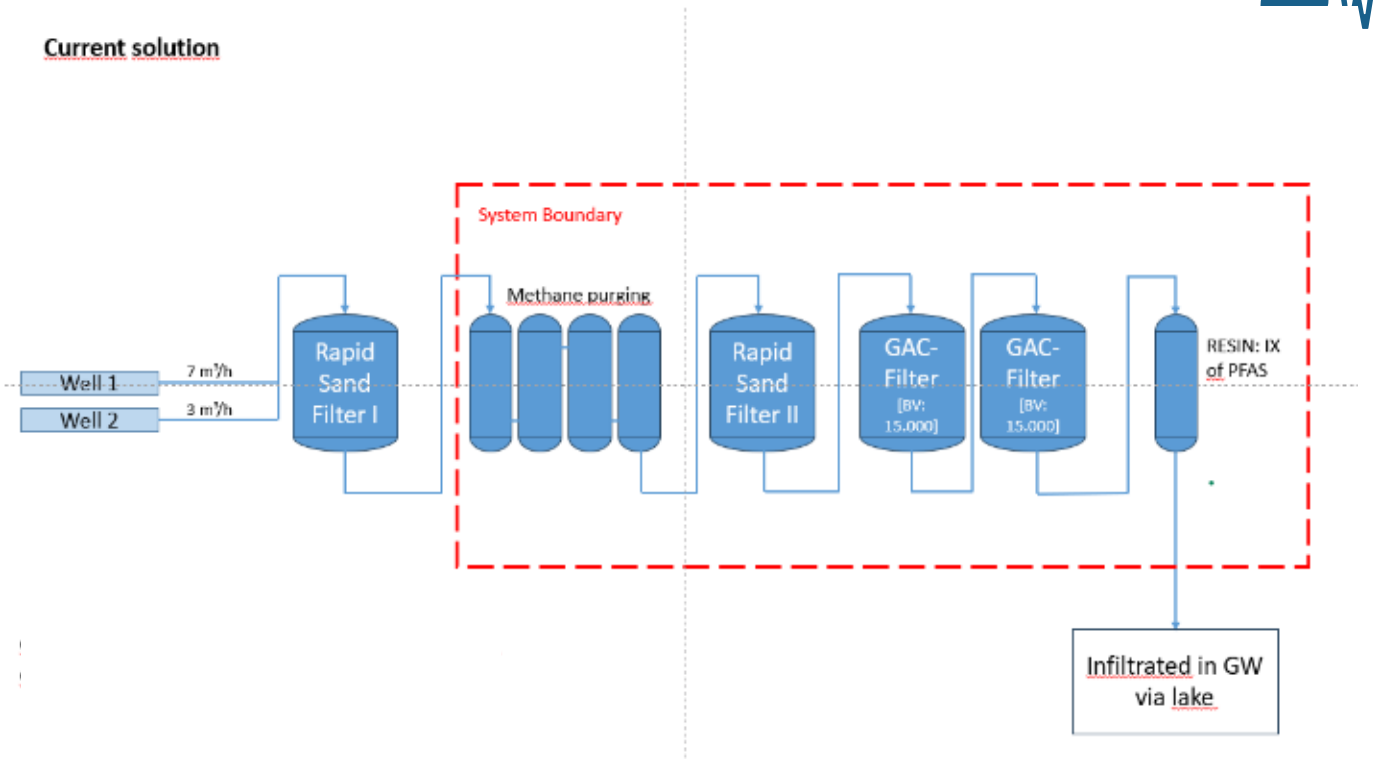
Conventional Alternatives

- Mix of the water from both wells
- Methane Removal
- Rapid filtration
- GAC System
- Resin Ion Exchange

Total CAPEX: € 321 186 (2 470 661 DKK)*

For reference:
MBBR + Biofilters:
€ 513 479 (3 832 779 DKK) ≈ 60% more expensive



Source: IWW

*Based on investment data from 2023 and 2024 (plant is new and still requires adaptations)
Excludes construction costs of the building
Excludes value of existing components or equipment brought from other sites

OPEX

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MBBR + Biofilters

Annual costs	
Manpower	98 000,00 €
Plant and ecological maintnanc	2 500,00 €
Pipeline maintnance	960,00 €
Energy Costs	3 975,88 €
Parts replacement MBBR	5 784,06 €
Overheads	2 643,99 €
Total	**113 863,93 €**

€1,30/m^3

GAC + IX *

Conventional Annual costs	
Manpower	98 000,00 €
Parts replacement	5 600,00 €
Energy Costs	22 076,81 €
Material/Parts	17 388,85 €
Other	2 854,18 €
Overheads	9 013,13 €
Total	**154 932,97 €**

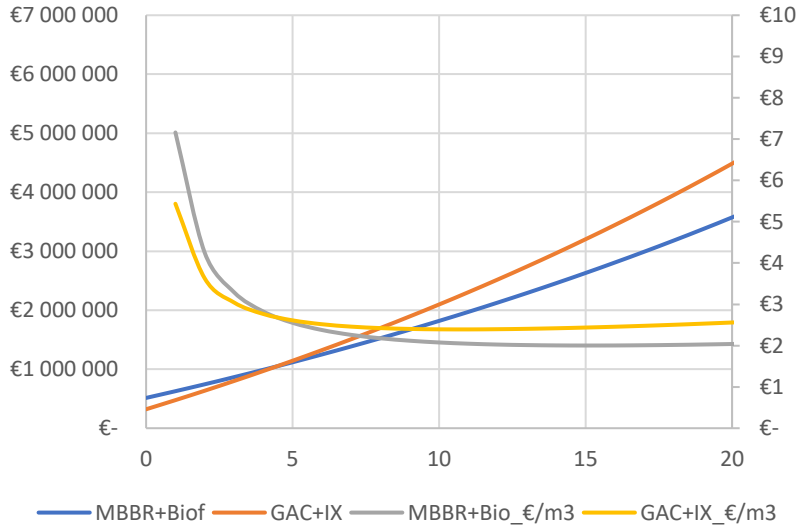
€1,77/m^3

*Based on data collected from January to October 2024

- Both solutions have similar manpower requirements, but different know-how.
- MBBR + Biofilter solution has significantly lower energy costs than GAC+IX (−82% energy consumption).
- MBBR + Biofilter solution avoids costs associated with Activated Carbon or Resin regeneration

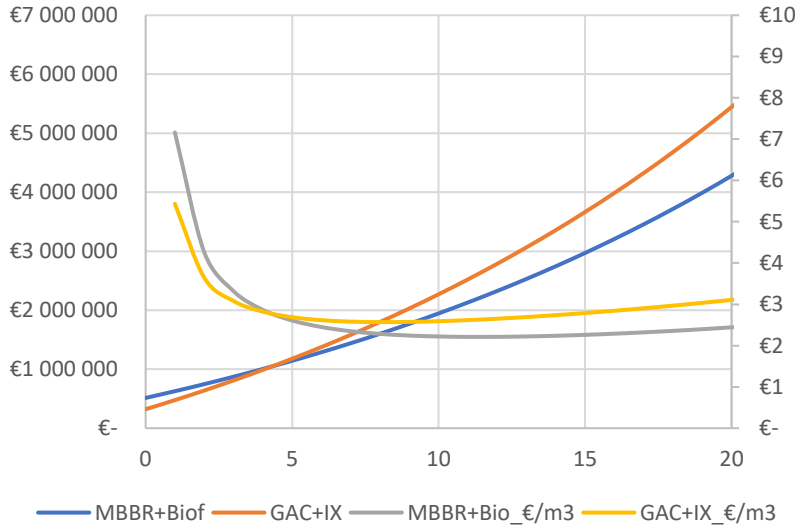
CAPEX + OPEX

Discont rate: 3%
Inflation: 3%



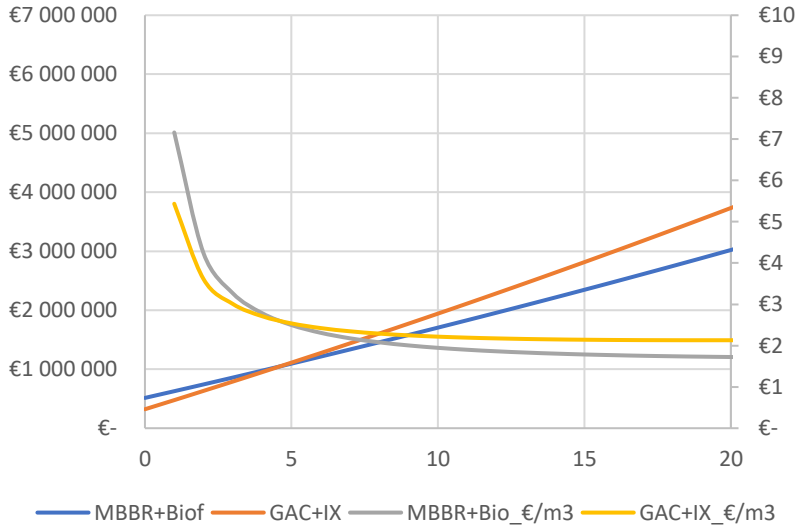
	Year 20	Year 30	Year 40
MBBR+Biof	3 573 046 €	5 930 603 €	9 098 963 €
GAC+IX	4 484 293 €	7 692 186 €	12 003 327 €
Total Surplus	911 247 €	1 761 583 €	2 904 364 €
MBBR+Biof (€/m3)	2,04 €	2,26 €	2,60 €
GAC+IX (€/m3)	2,56 €	2,93 €	3,43 €

Discont rate: 3%
Inflation: 5%



	Year 20	Year 30	Year 40
MBBR+Biof	4 278 499 €	8 078 468 €	14 268 216 €
GAC+IX	5 444 192 €	10 614 754 €	19 037 053 €
Total Surplus	1 165 694 €	2 536 286 €	4 768 837 €
MMBR+Biof (€/m	2,44 €	3,07 €	4,07 €
GAC+IX (€/m3)	3,11 €	4,04 €	5,43 €

Discont rate: 3%
Inflation: 1%



	Year 20	Year 30	Year 40
MBBR+Biof	3 020 650 €	4 474 224 €	6 079 874 €
GAC+IX	3 732 656 €	5 710 512 €	7 895 297 €
Total Surplus	712 006 €	1 236 289 €	1 815 423 €
MBBR+Biof (€/m3	1,72 €	1,70 €	1,74 €
GAC+IX (€/m3)	2,13 €	2,17 €	2,25 €

Conclusive Remarks

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- The upscaling of the pilot MBBR + Biofilter solution demonstrates technical and economical feasibility, specially when considering longer operational periods
- Lower OPEX than conventional technologies. Similar CAPEX.
- Lower ecological footprint: reduced energy usage, and no consumption of resins and activated carbon
- Ease of replication: Can be built virtually everywhere. Wells can be placed next to pollution source and MBBR reactors and Biofilters nearby. Alternative Managed Aquifer Recharge solutions may be required depending on the site.
- Can be integrated in Hybrid solutions, reducing overall costs.

THANK YOU FOR ATTENDING!

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Tiago Carvalho – TARH
Tiago.Carvalho@tarh.pt