Algal cultivation in RAS process water

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Finnish Environment Institute

SAFE - SmartAqua4FuturE

Reducing the environmental impact of freshwater aquaculture by applying circular economy approaches

Funded by the European Union

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Finlands miljöcentral
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RAS-prosess water

✓ Using the RAS process water for algal cultivation
-> reducing the carbon footprint and nutrient costs

+ plenty of nitrogen
+ steady supply

- some seasonal variation
- nutrients not in optimal ratios

	median	
	stage 3	stage 4
	mg/L	mg/L
TOT-N	51	29
NO2+3-N	45	25
NH4-N	0.22	0.86
TOT-P	2.7	0.068
PO4-P	2.6	0.010
SiO2-Si	0.8	0.5

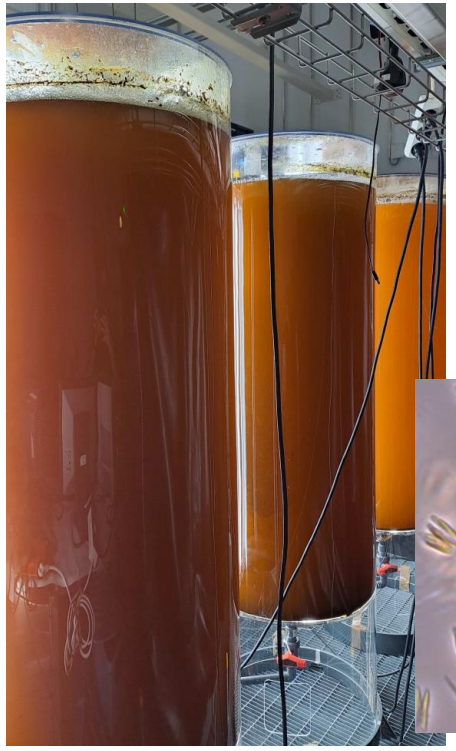
Trace elements (µg/L):
Mn <3, Se <0.5, Fe 50, Zn 13 µg/L

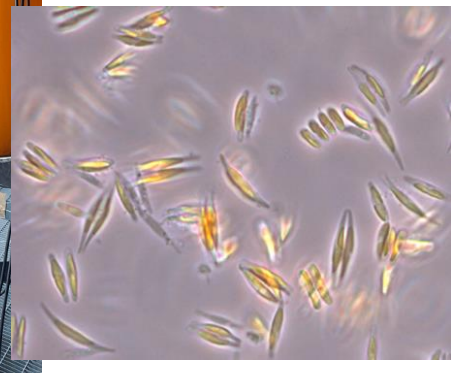


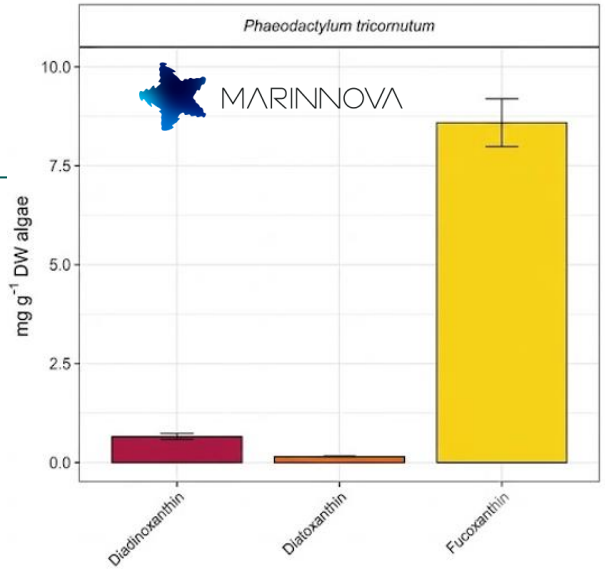
Algal species

Diatom *Phaeodactylum tricornutum* (TV335 strain)

- grows fast
- produces EPA (omega-3 PUFA): 30% EPA of total FAs
- contains fucoxanthin
- settles

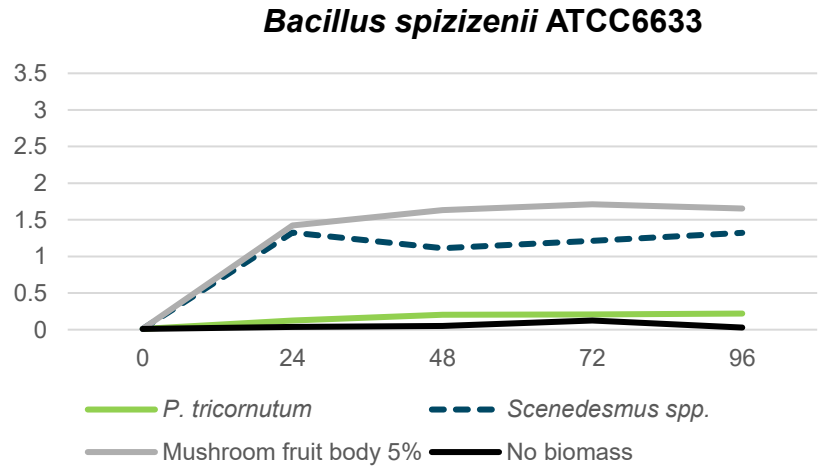


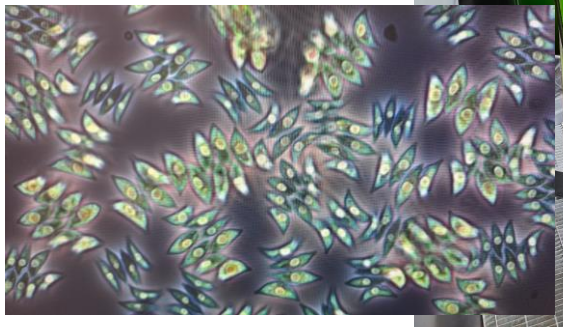




Green algae *Scenedesmus* sp. (contamination)

- grows fast
- resistant to grazers
- has prebiotic properties
- settles







Cultivation

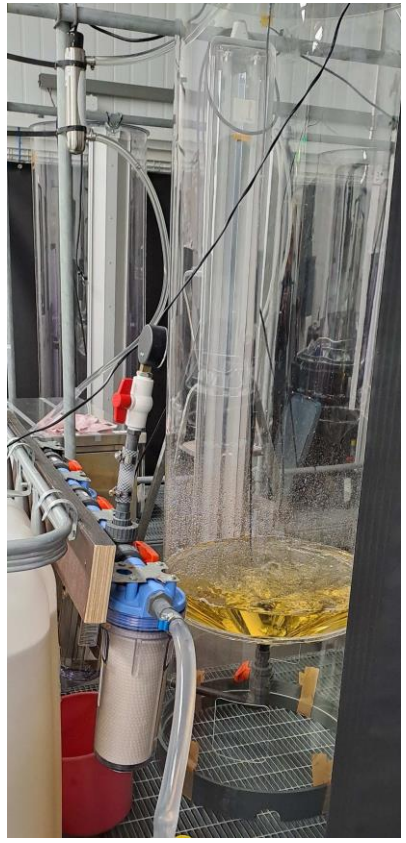
LCA case #1

RAS-process water:

- contains organisms, has N:P 30-45, is low in Mn, Co, Mo, Fe

Pre-treatment

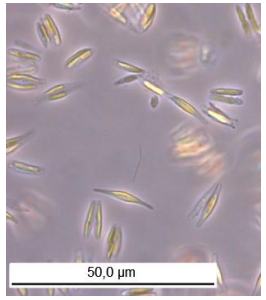
- Filtering
- UVC



P-addition
N:P (mol) 8-10

TM-addition

TV335 strain



+ light
+ aeration
+ CO2





Algal cultivation in RAS process water (SAFE-project)

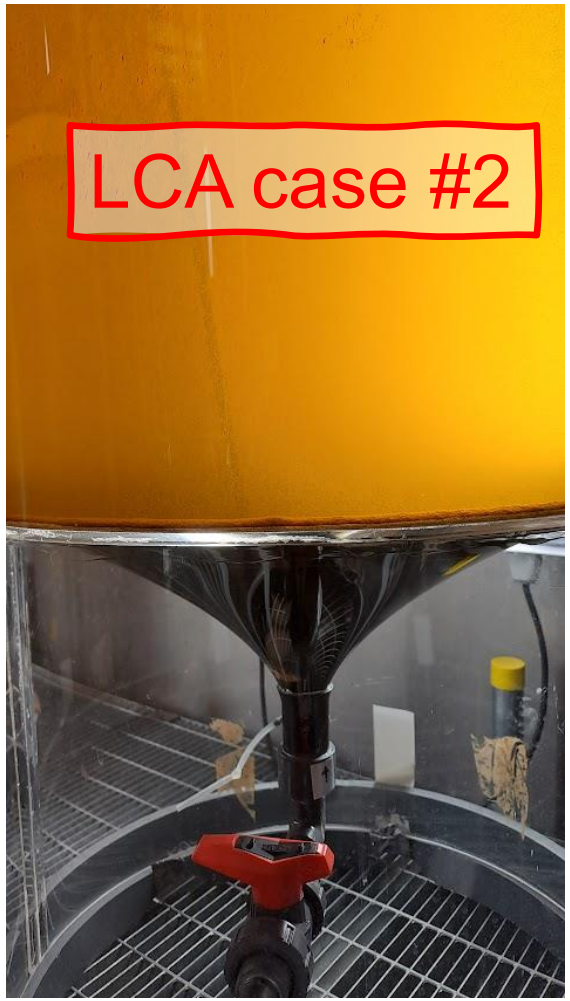
Video on Syke YouTube
https://www.youtube.com/watch?v=_xL_6QyTbaE

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Biomass harvesting and processing

✓ Utilize settling in biomass harvesting
-> reducing the energy consumption

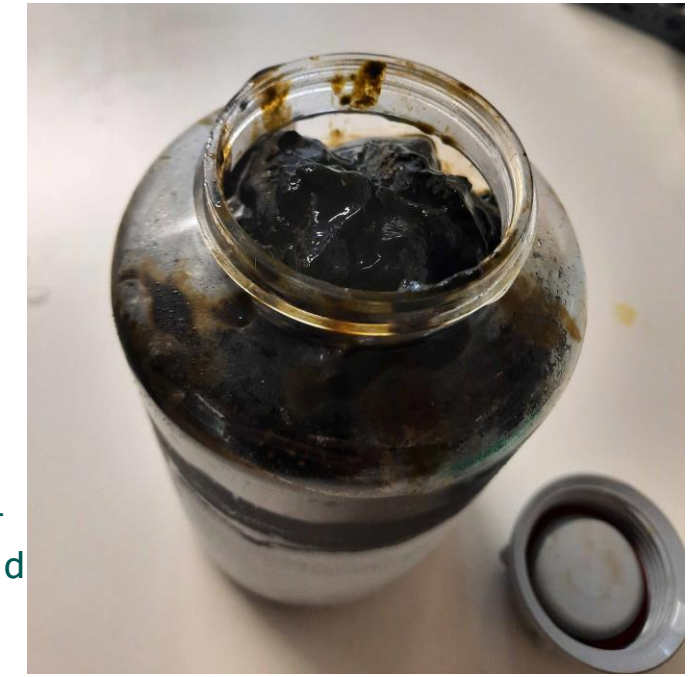
Harvesting by settling



+ Supplementation with RAS water

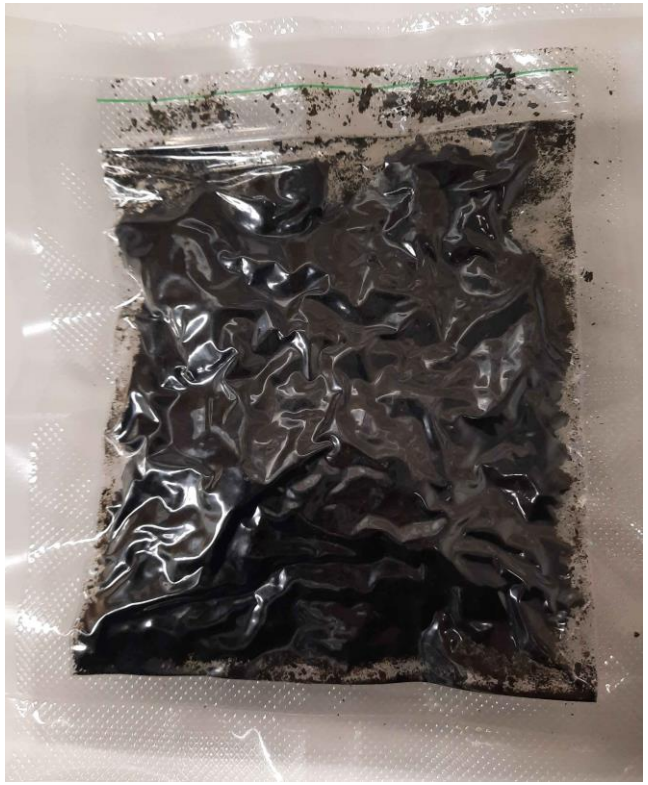
Cultivation under N-limitation for 5 d

Centrifugation



Freeze-drying

Vacuum packing



+ no lag-phase between subsequent rounds
+ centrifugation of smaller volumes
+ self settling – no chemical addition needed

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Sludge as nutrient source

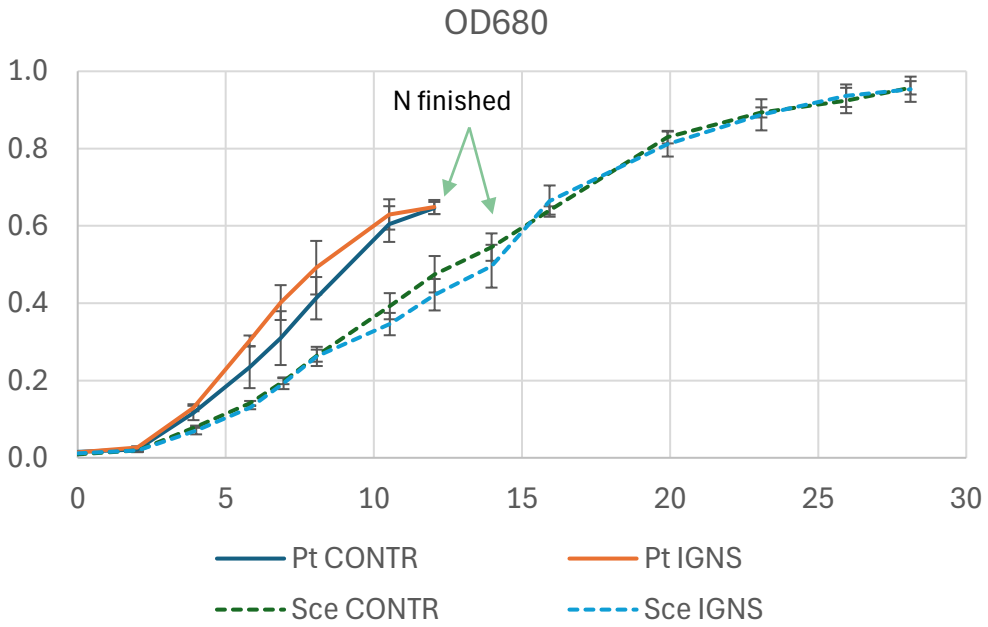


Combustion





Acid extraction



	Osan Settefisk, Norway salmon smolt
Macronutrients	g/kg
N	39
P	46
Trace elements	mg/kg
Fe	6 300
Zn	720
Mn	310

1 kg dried sludge -> P-addition to 12x 315-L cultivations

LCA case #3

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Feed trials with the algal biomass





Microalgae as micro-ingredient (max. 5% inclusion)
- Functional; providing beyond the fundamental nutrients

The effects on the fish physiology, nutrition and health status

ciimar
Centro Interdisciplinar de Investigação Marinha e Ambiental

Ollscoil na Gaillimhe
University of Galway

KEYWATER FISHERIES
SUSTAINABLE IRISH PERCH

Rainbow trout

+Partially replaces soybean meal and fish oil

- 2.5% - 5% ***Phaeodactylum tricornutum***

- 2.5% ***Phaeodactylum tricornutum***
  2.5% ***Scenedesmus* spp.**

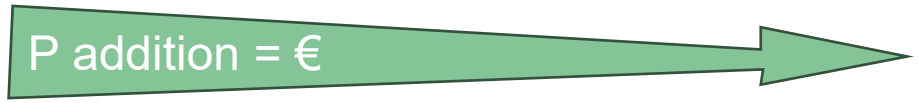
Salmon and perch

+Partially replaces soybean meal, wheat meal and fish oil

- 2.5% - 5% ***Phaeodactylum tricornutum***

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Costs



LCA

Change in nutrient costs

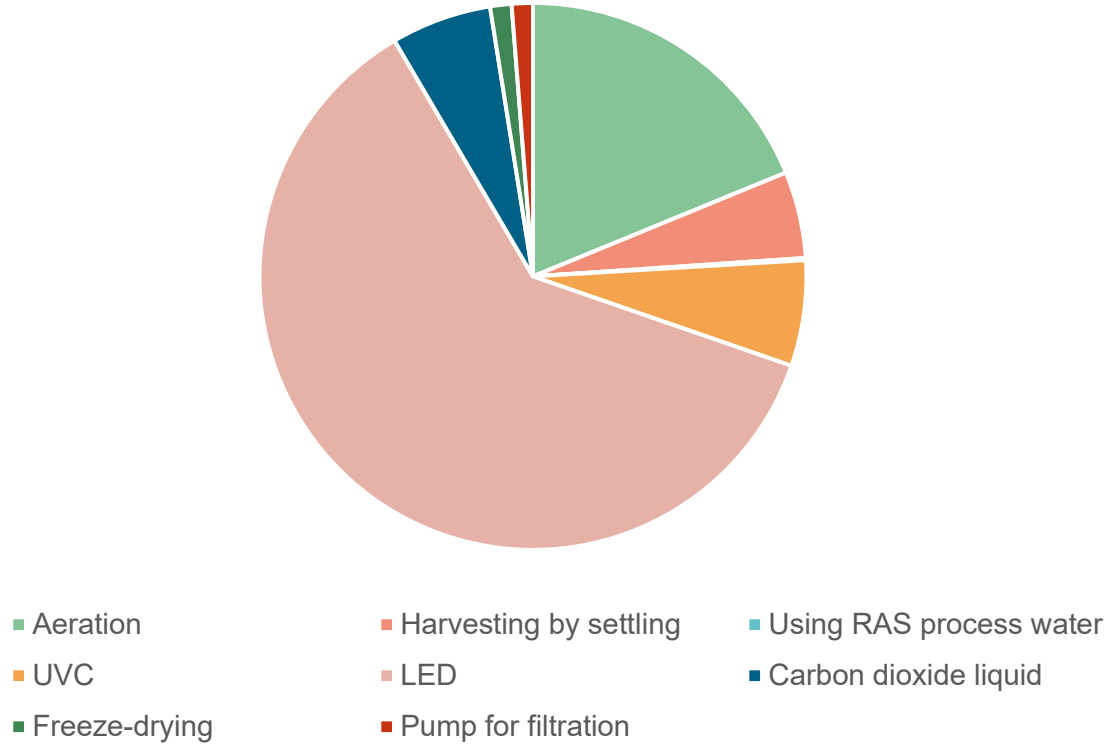
vs. lake water + nutrients	N:P 8	N:P 12	N:P 16
RAS process water	-43%	-54%	-62%
RAS + sludge extract	+33%	0%	-23%

Change in harvesting costs

vs. centrifugation	
Settling	-75%

LCA results

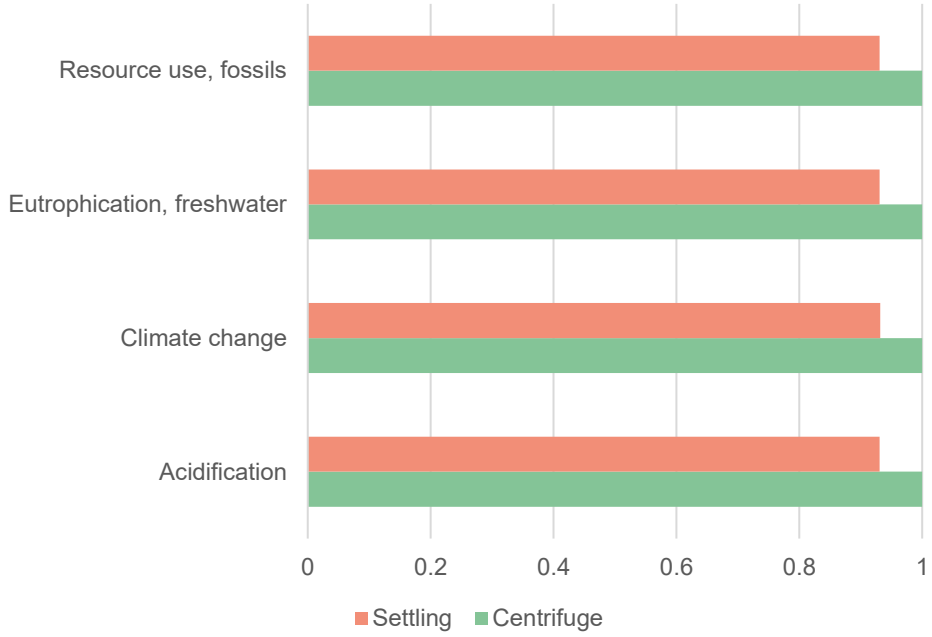
Tanja Myllyviita



The majority of the environmental burden is associated with the electricity used for lighting

- LED-lights would reduce it from ca 80% to 65%

LCA case #2

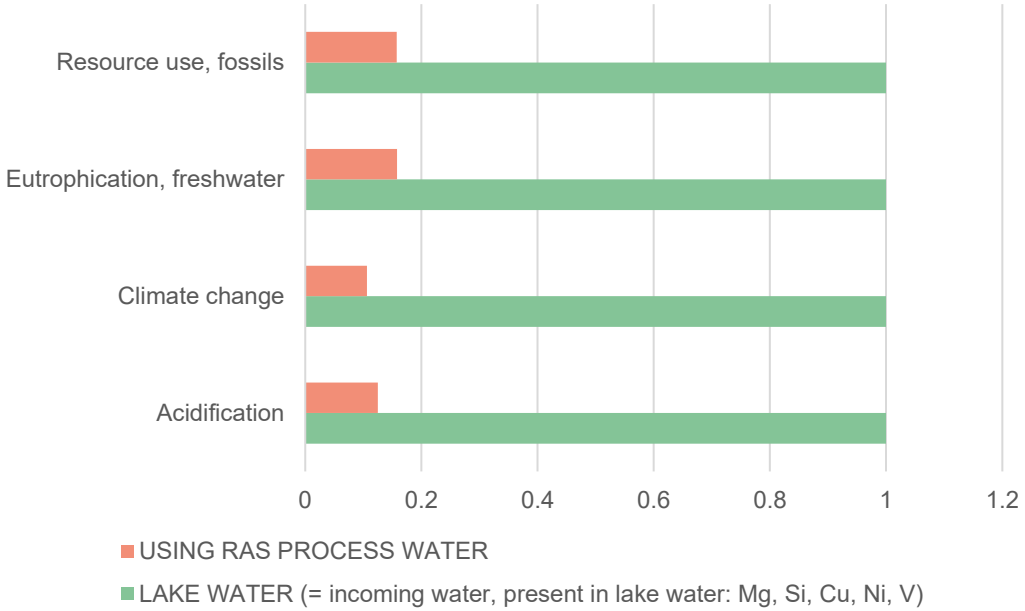


The use of settling instead of centrifugation

- reduction in the environmental impacts of microalgae cultivation by ca. 7%.

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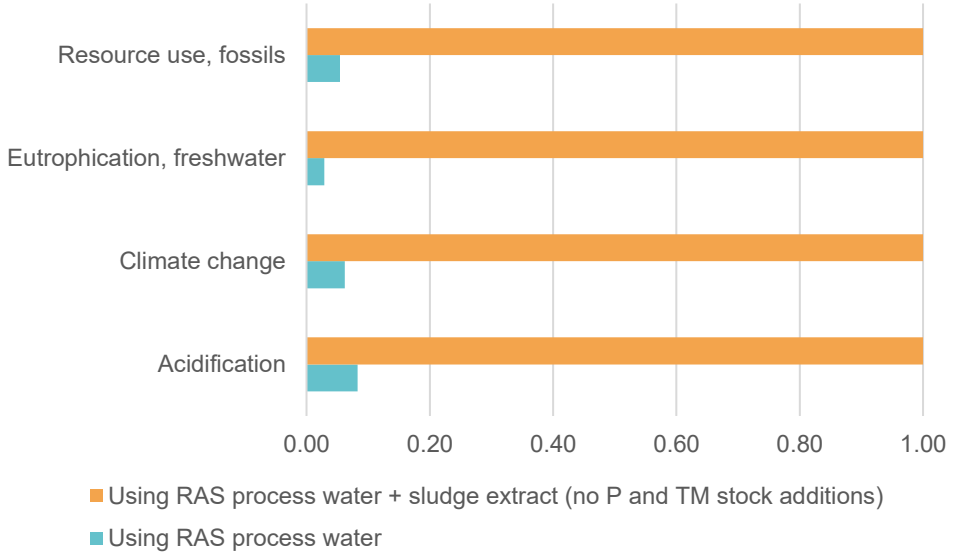
LCA case #1



The use of RAS process water instead of lake water for microalgae cultivation

- reduction in environmental impacts by ca. 87% on average (considering nutrient input only).

LCA case #3



The use of RAS process water together with sludge extract

- no environmental benefits due to the NaOH addition.
- the overall environmental impacts increased (considering nutrient input only

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Thank you for your attention



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