Zero emission of water and nutrients in a Dutch greenhouse ?

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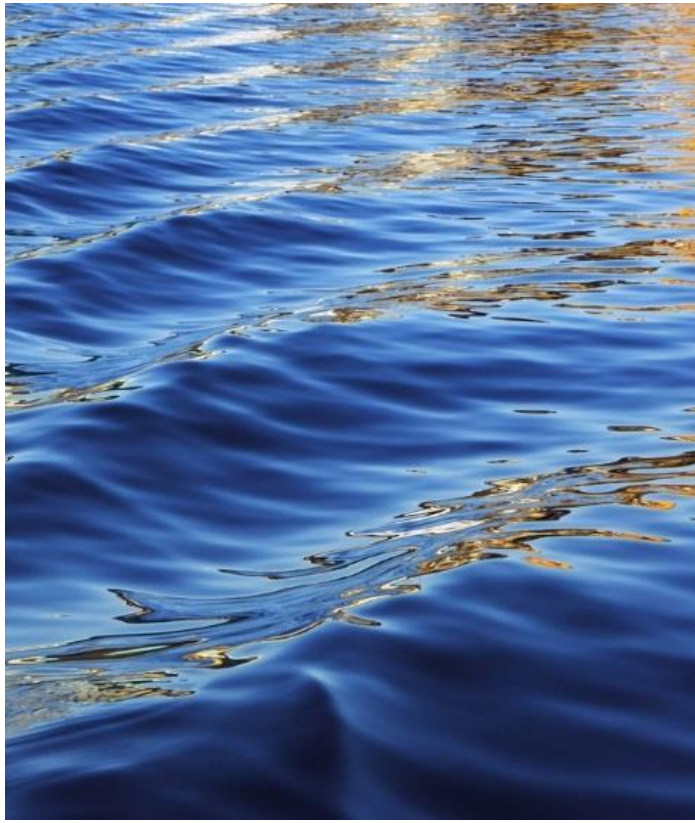
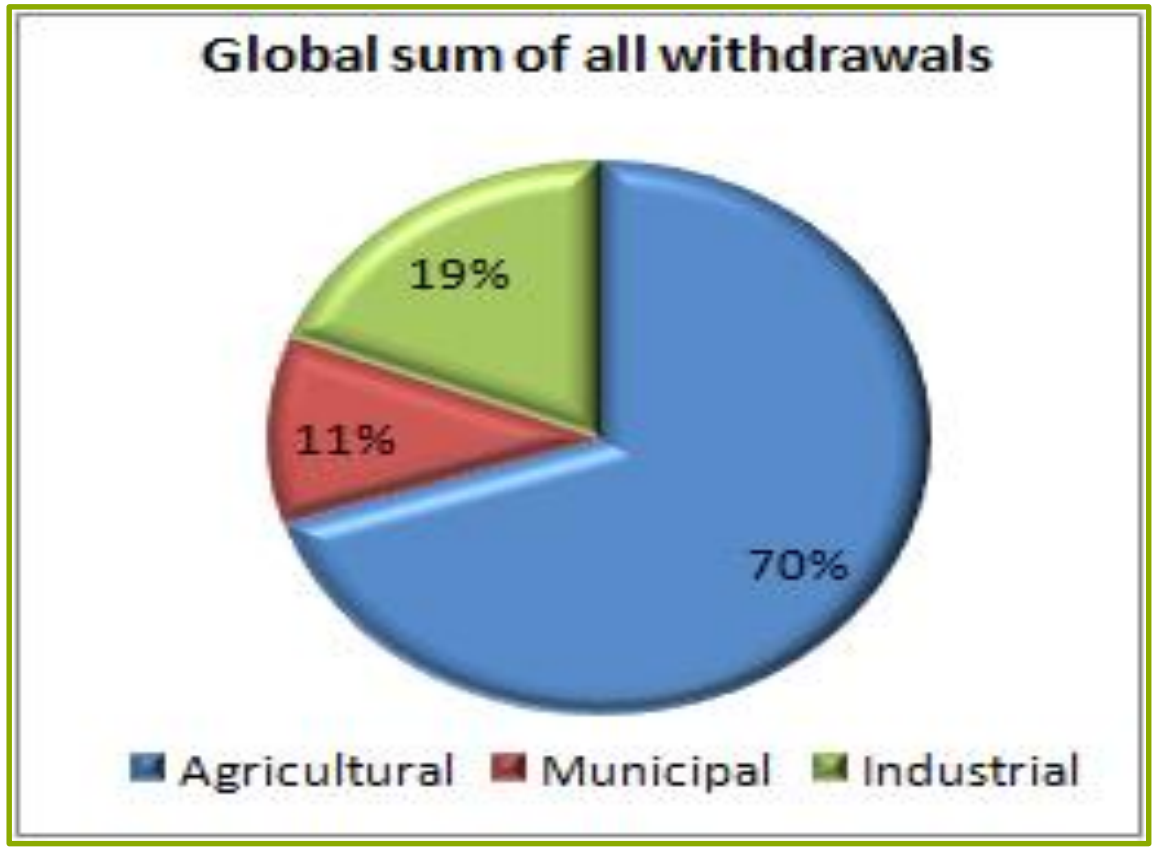
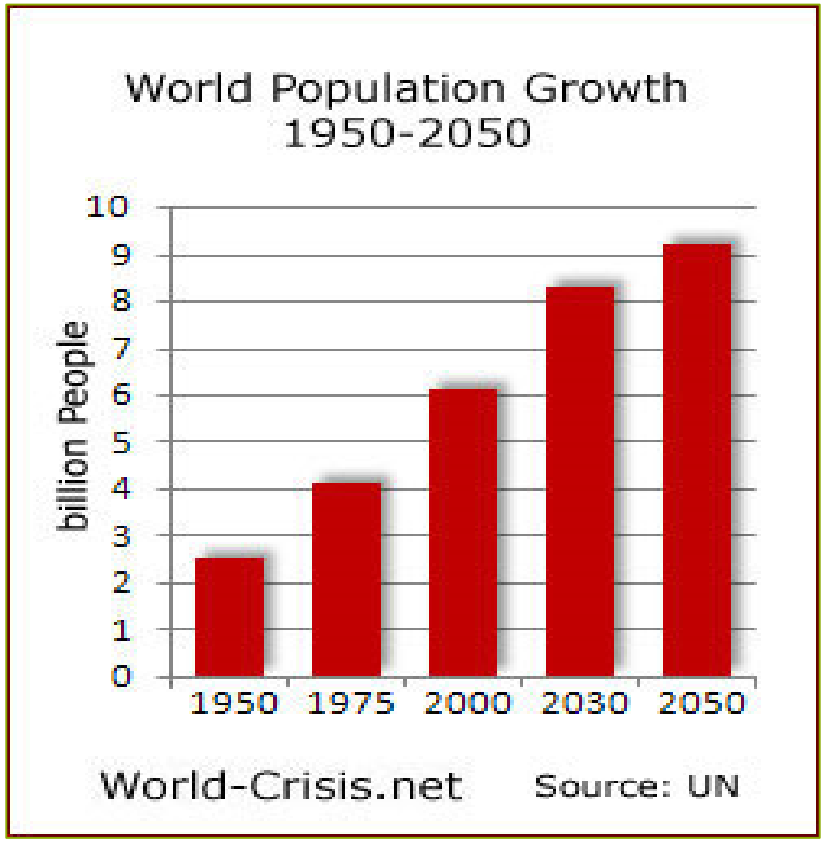
Water - Food



water scarcity





Dutch greenhouse – success story

Facts

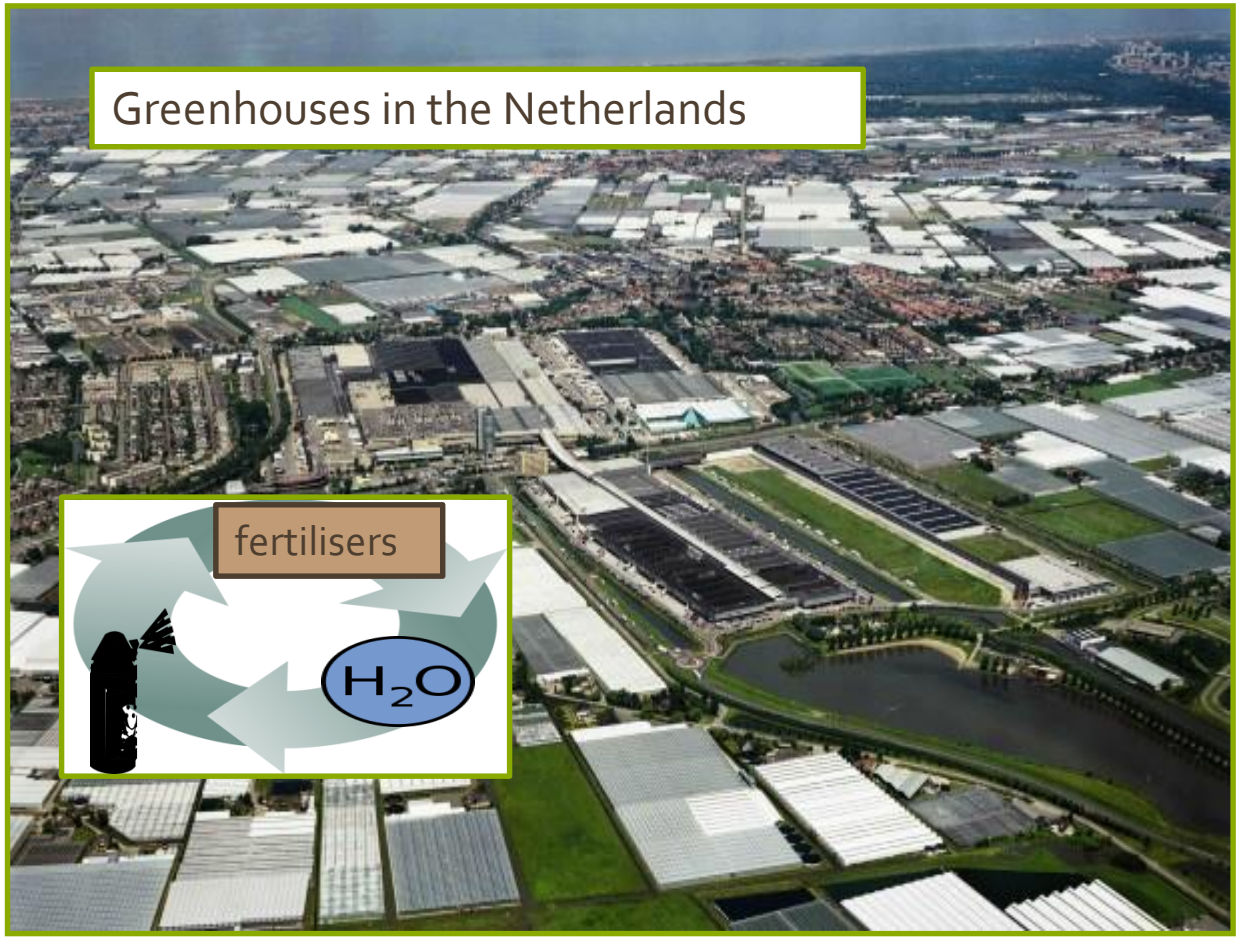
- world 2nd biggest food exporter
- huge area's are covered by glass
- crop yield more than double
- technology and science pushing to agricultural boundaries
- 90 % reduction of water usage

Amazing

- the Netherlands
- densely populated
- No.1 USA – 270 * bigger
- 140 countries adopted Dutch greenhouse technology

Source National Geographic – World Economic Forum

Dutch greenhouse – limitations



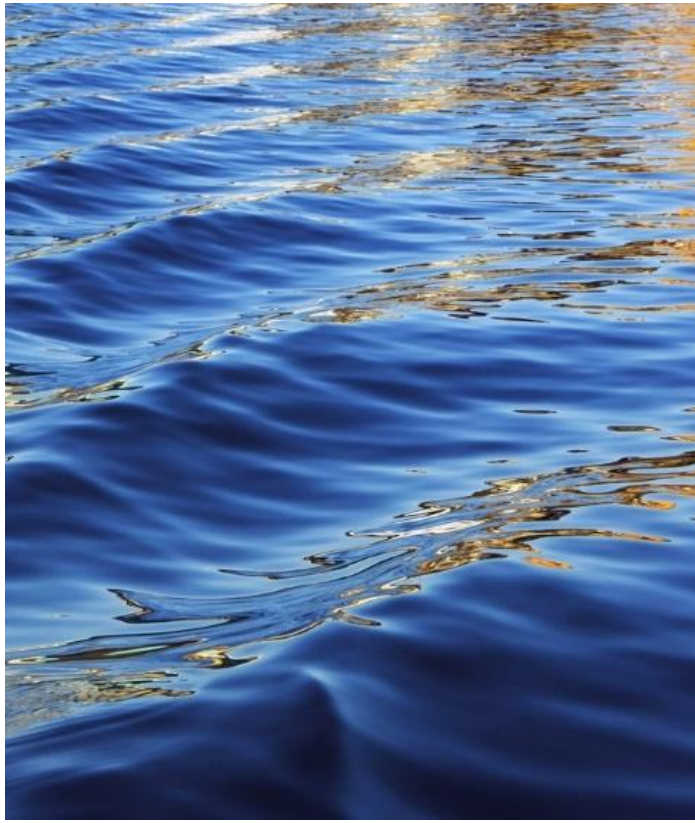
Water discard

Reason
- high Na^+
- poison for crops

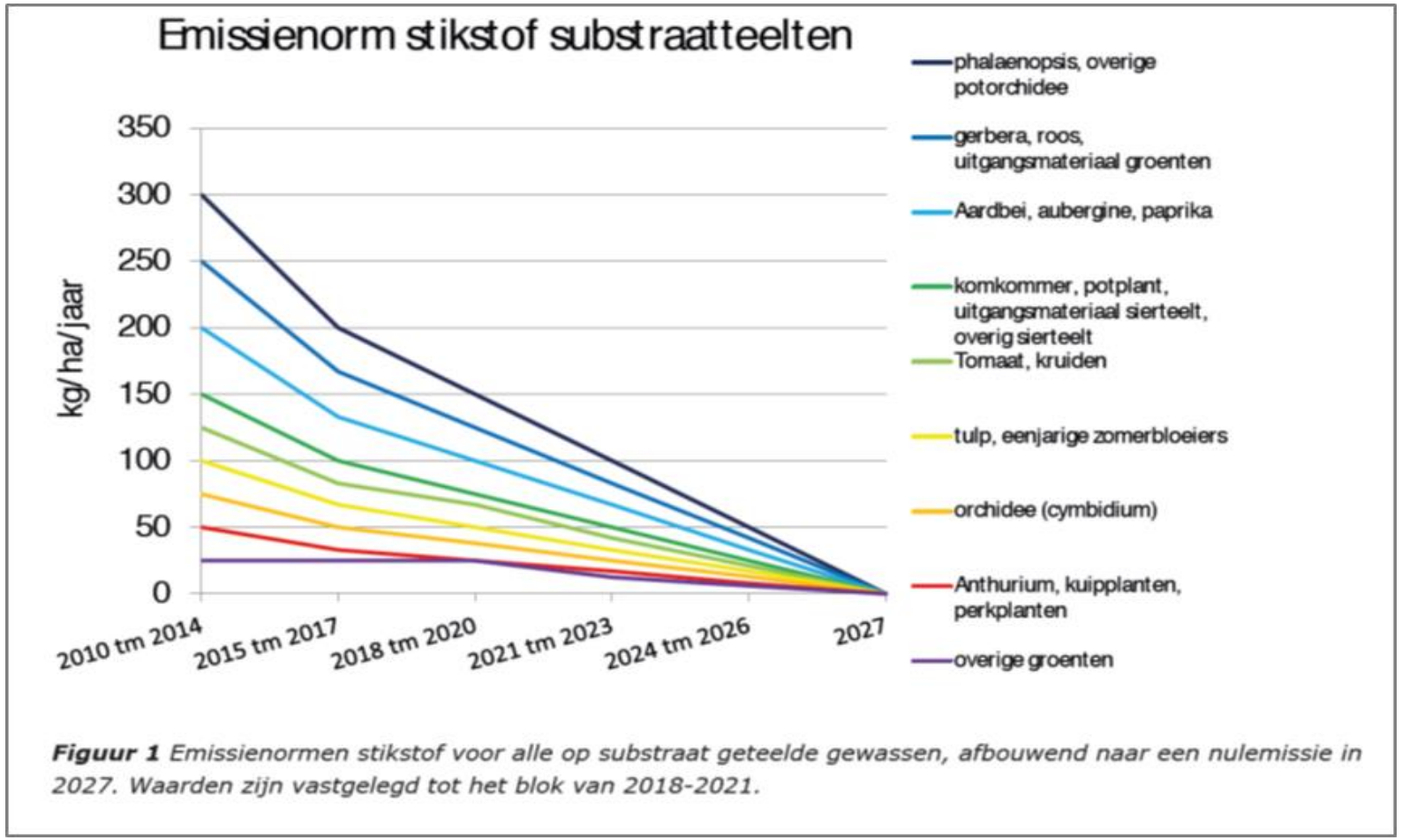
Consequence
- pesticide release
- environmental pollution
- 2018: forbidden

Longer term
- 2027: zero emission

Zero emission possible ?



ambition of Dutch government



Figuur 1 *Emissienormen stikstof voor alle op substraat geteelde gewassen, afbouwend naar een nulemissie in 2027. Waarden zijn vastgelegd tot het blok van 2018-2021.*

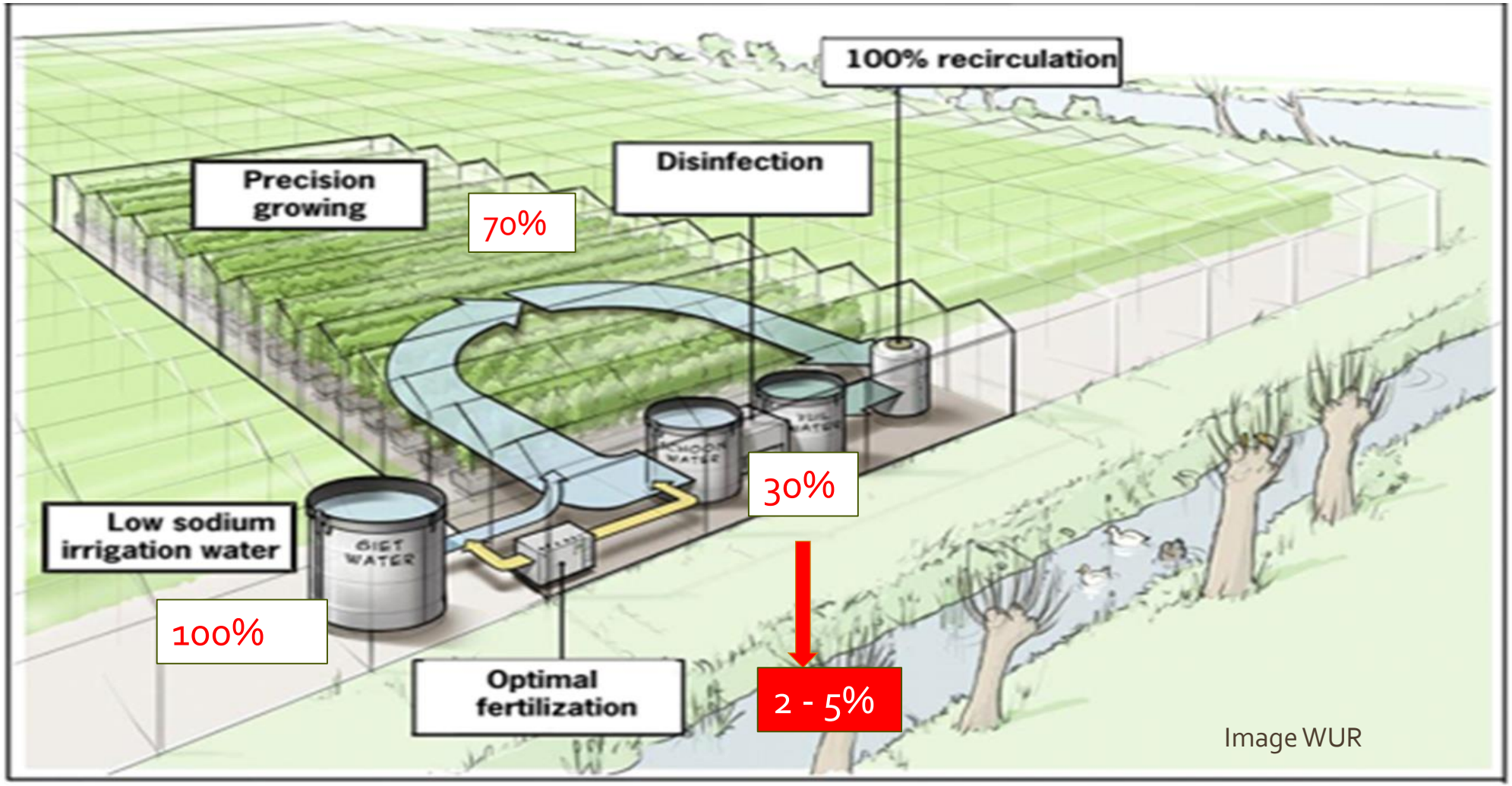
2027 target

- no emission of water
- no emission of nitrates

collaborative approach

- implement best practice
- no penalties (yet)

greenhouse practice – water & nutrient balance



Netherlands - environmental impact

rough calculations

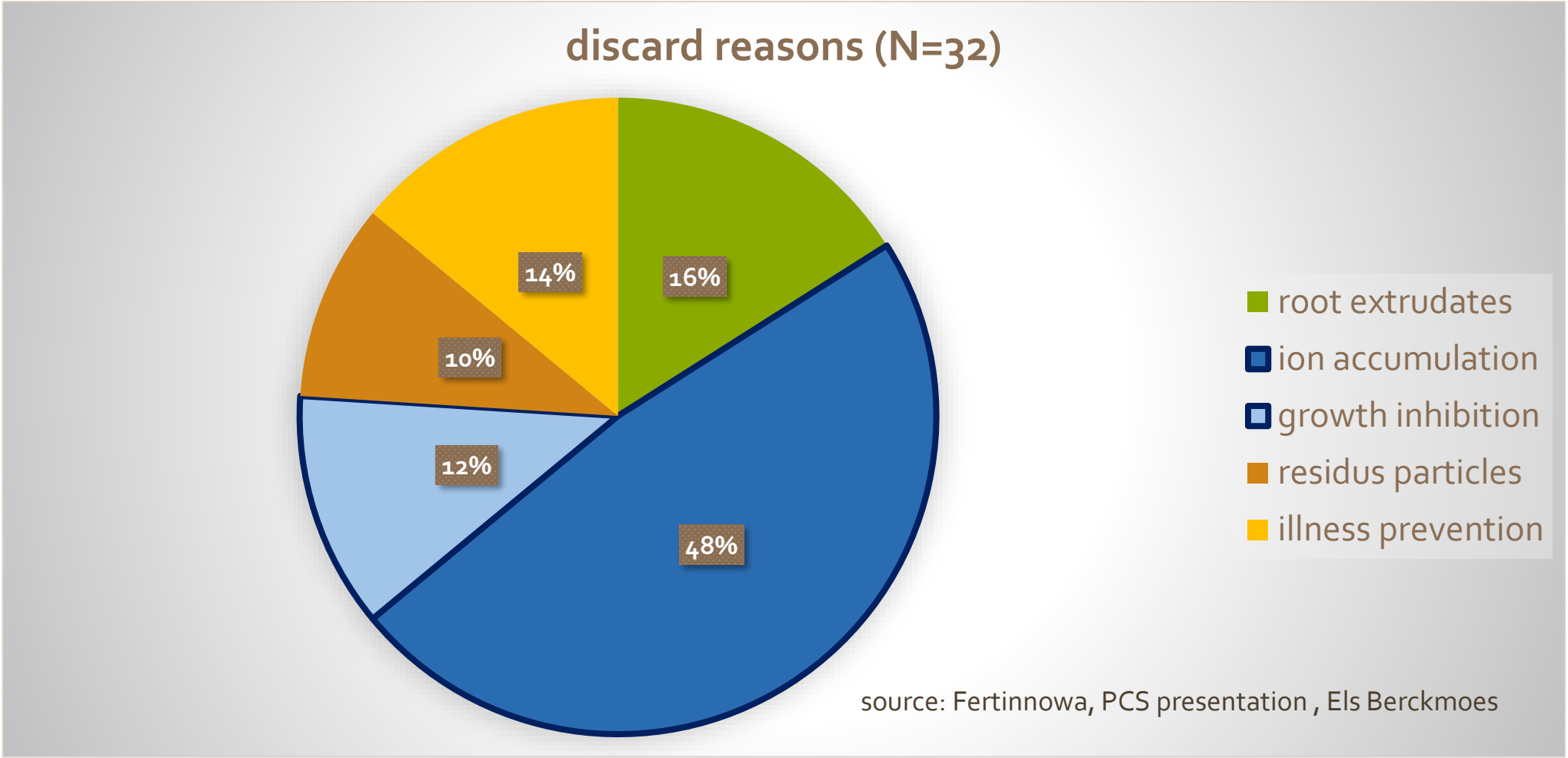
- average daily discard : 2 m^3 per hectare
- NL greenhouse total : 10.000 hectares
- **water discard : 20.000 m^3 daily**

- concentration nutrients : 2.5 kg / m^3
  - Na^+, K^+, Ca^{2+} Mg^{2+}
  - NO_3^-, Cl^-, SO_4^{2-}, PO_4^{3-}
  - micron nutrients: Fe, Mn, Zn, B, Cu, Mo
- **nutrients discard : 50.000 kg daily**

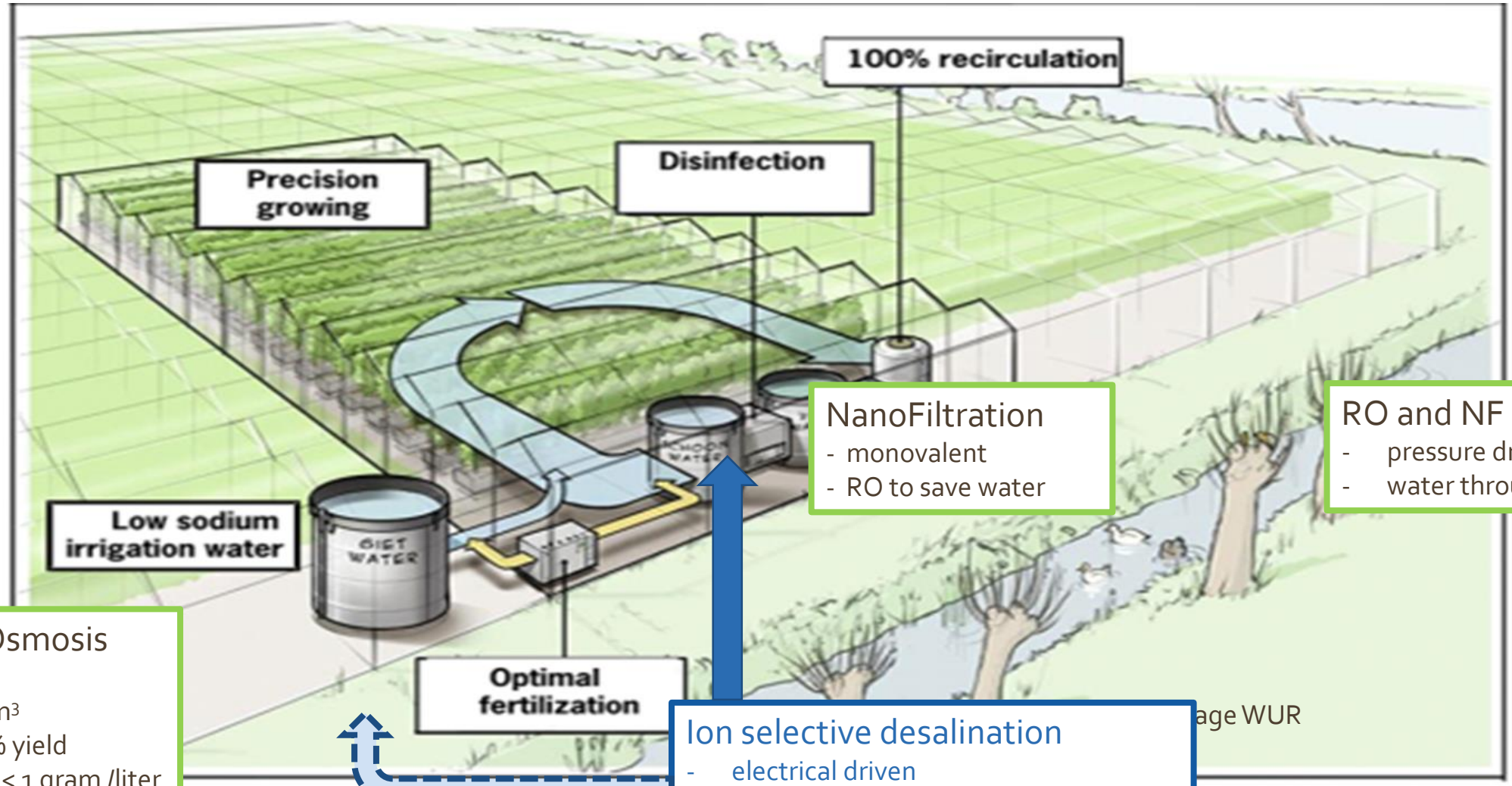
discard after treatment

- surface water
- sewer

reason – Na^+ accumulation in Drainwater



Zero emission – best available technology



Reverse Osmosis
- mature
- 2 kWh/m³
- 50 - 80 % yield
- remove < 1 gram /liter

NanoFiltration
- monovalent
- RO to save water

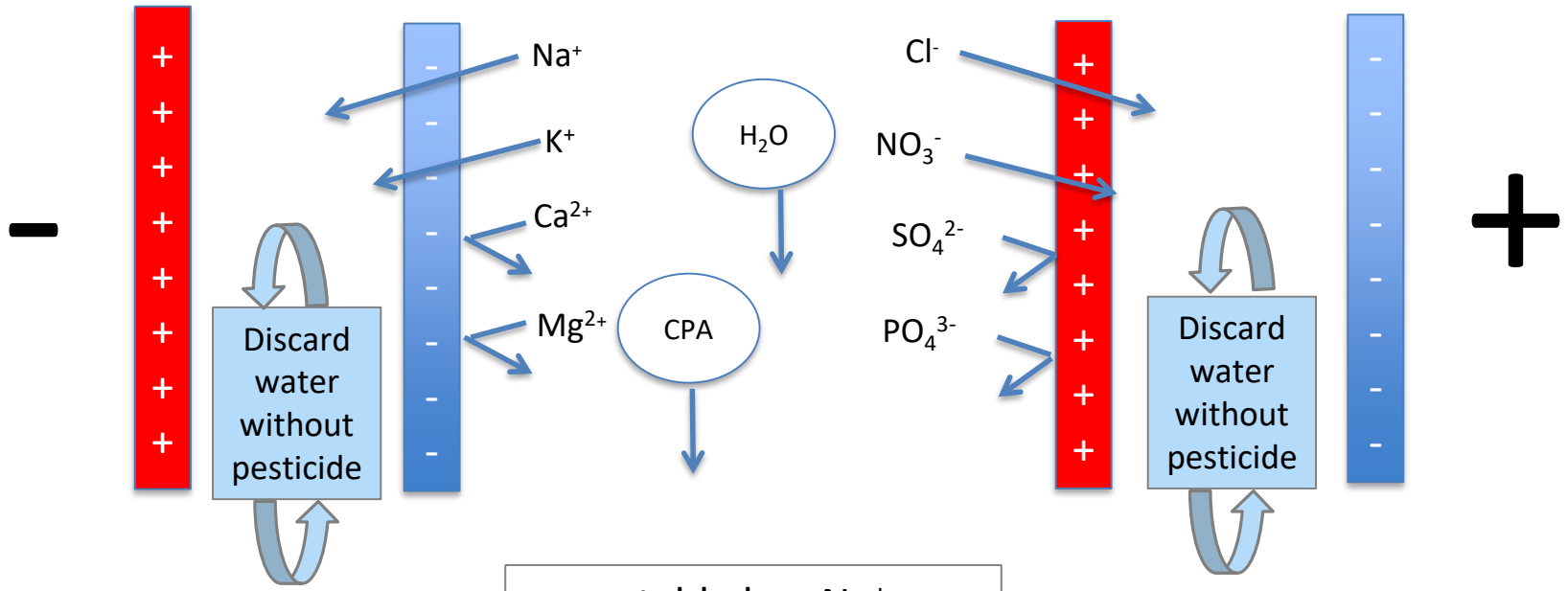
RO and NF
- pressure driven
- water through filter

Ion selective desalination
- electrical driven
- salts through filter

technology under development

An ion-selective desalination system in drainwater recycling

Greenhouse drain water recycling



stable low Na^+ re-use in greenhouse

Greenhouse fieldtest results

ion selective desalination system on GH drainwater

Advantages

- ✓ efficient Na^+ removal
- ✓ stable Na^+ level in drain and irrigation water
- ✓ > 80% water saving
- ✓ 80% multivalent nutrient savings
- ✓ 80% micro nutrient savings
- ✓ no pesticide emission (to be proven and certified)
- ✓ simple and efficient
- ✓ cost effective

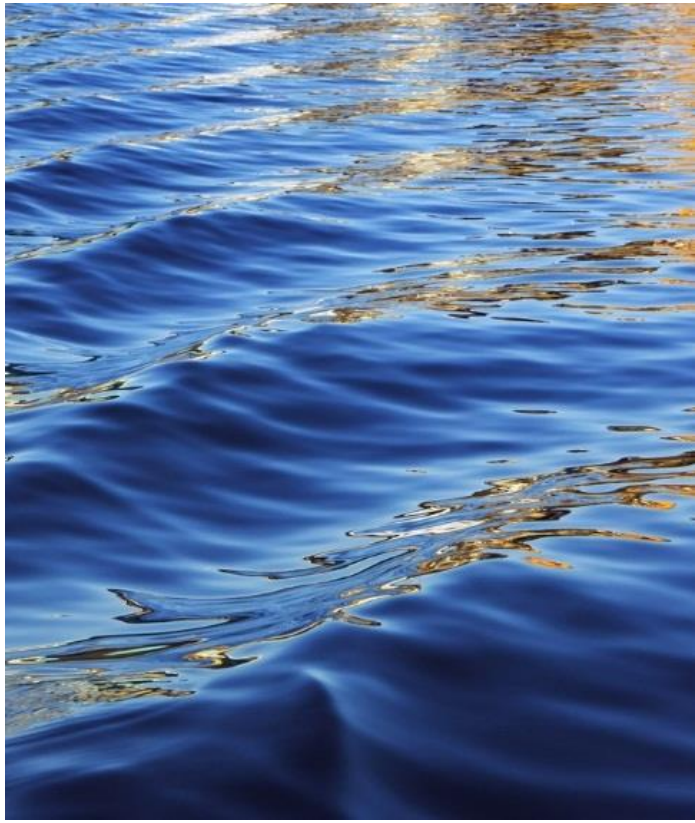
Attention points

- equimolar loss of KNO_3
- concentrated waste stream
  - 20% of orginal waste
  - mainly NaCl and KNO_3, no pesticide
  - valorise , find suitable application

Upscaling ongoing to full scale

Summary

- zero emission target is not unrealistic
- best available technology needed
- ion selective desalination adds value
- find decent solution for concentrated waste stream



thank you for your kind attention

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