VicInAqua

Turning water and energy challenges into opportunities

- The case of VicInAqua -

Hochschule Karlsruhe
Technik und Wirtschaft
UNIVERSITY OF APPLIED SCIENCES

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VicInAqua has received funding from the **European Union's Horizon 2020 research and innovation programme** under grant agreement No **689427**.

VicInAqua Rationale

- High population density & rapid urbanisation
- High rate of poverty & poor sanitation system
- Growth of fish processing industry
- High wastewater discharge into the Lake Victoria → overfertilisation
- Overfishing → depletion of fish stocks
- Lack of awareness on environmental impact of fisheries & wastewater discharge

Aquatic weed outbreaks in Lake Victoria

Photo Credit:
sarah_mccans via flickr (CC BY 2.0 license)

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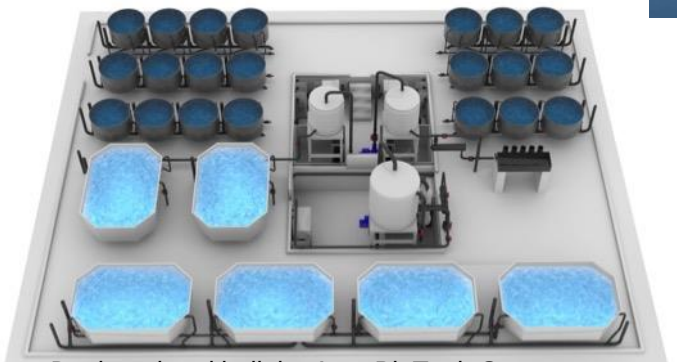
No Silver Bullet Solution

There is **no single one-fix solution** to any of these challenges. But there are ways one can help meet the world's water and energy challenges.

VicInAqua is a research project **to develop and integrate new technologies** addressing both water and energy challenges **AND** to draw key learnings on **how such technologies can be made available** in environments as such in Kenya.



Designed and built by AquaBioTech Group

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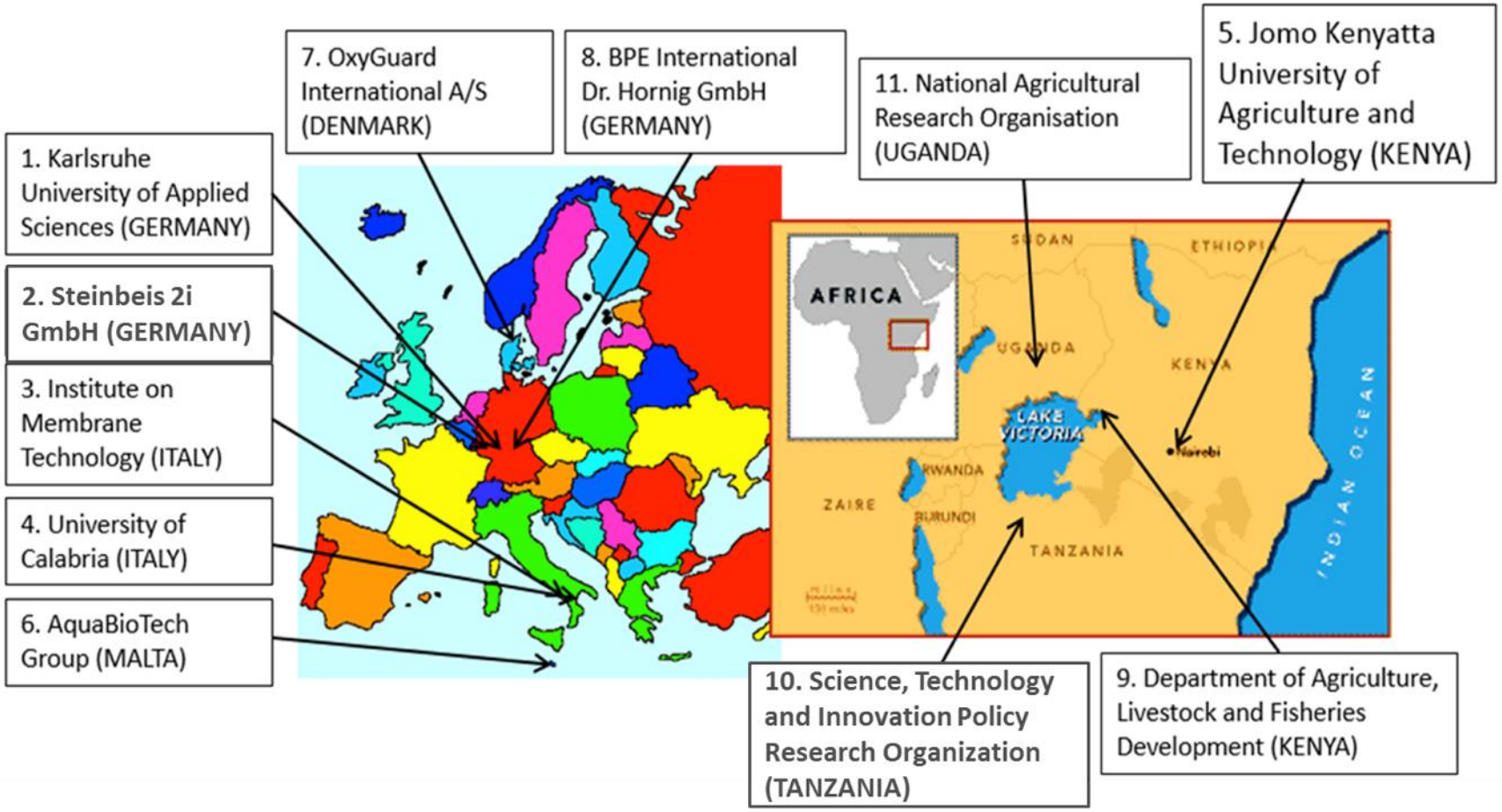
VicInAqua Consortium



11 partners from 7 different countries (7 European and 4 African)

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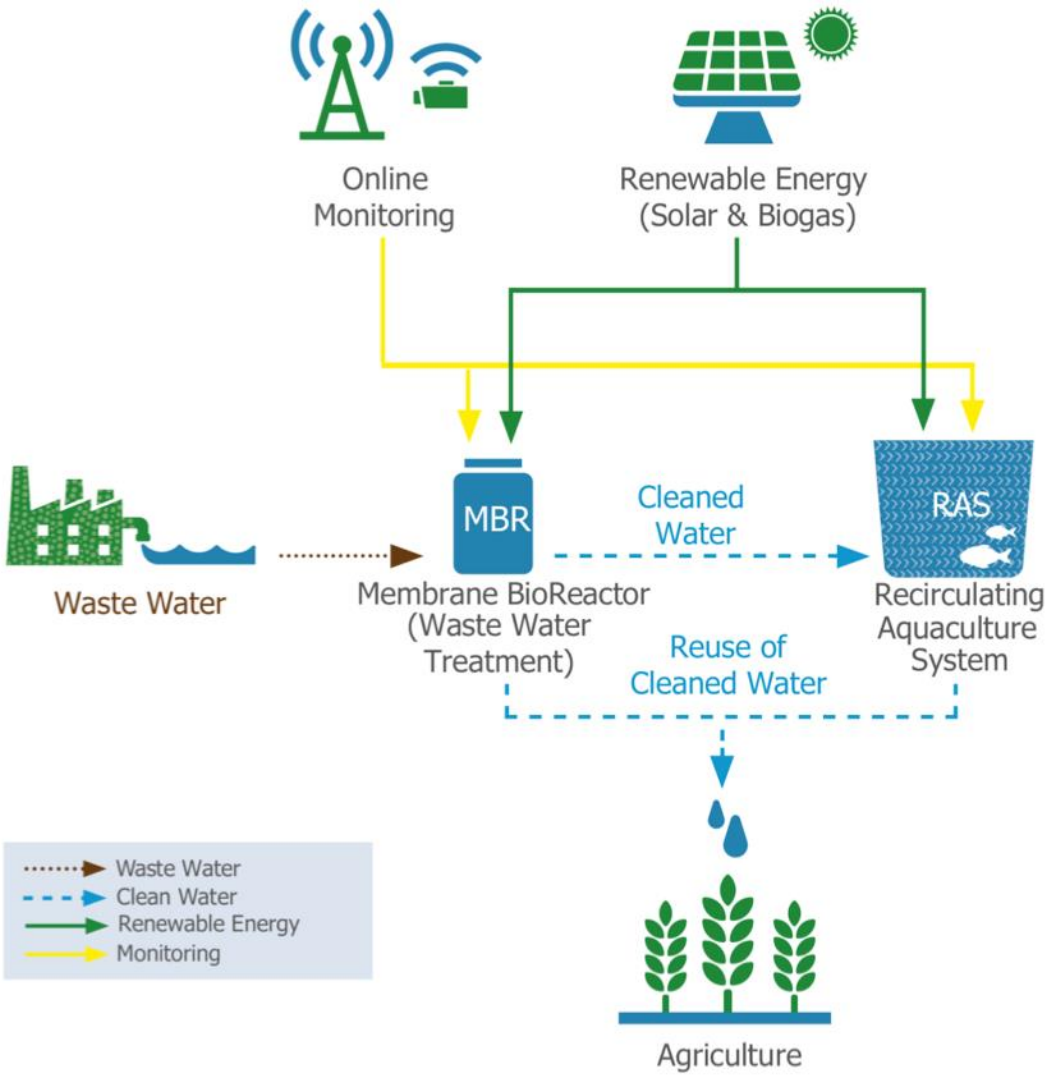
VicInAqua Technical Concept

- ✓ Develop a novel multipurpose filter system (Membrane bioreactor-MBR).
- ✓ Develop a novel high efficient energy supply system (Biogas, PV solar).
- ✓ Design a Recirculation Aquaculture System (RAS)
- ✓ Develop a robust, low cost control system in real time
- ✓ Re-use water in RAS and for irrigation.



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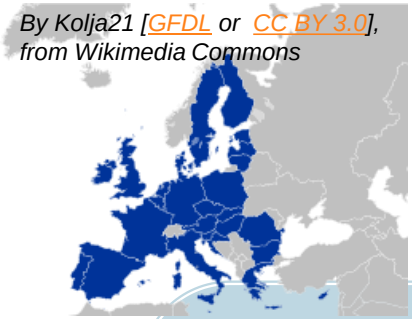
VicInAqua Knowledge Transfer



Technology transfer
(technical trainings, education etc.)

Pre-filtration

MBR and membrane coating

Recirculation aquaculture system

Energy generation & storage

Robust sensor system

Smart control system

Ethical and cultural aspects

Geological aspects

Local / national legislation

Life Cycle Assesment

Biogas production

Project acceptance

Socio-economic aspects,
Sustainable impact assessment

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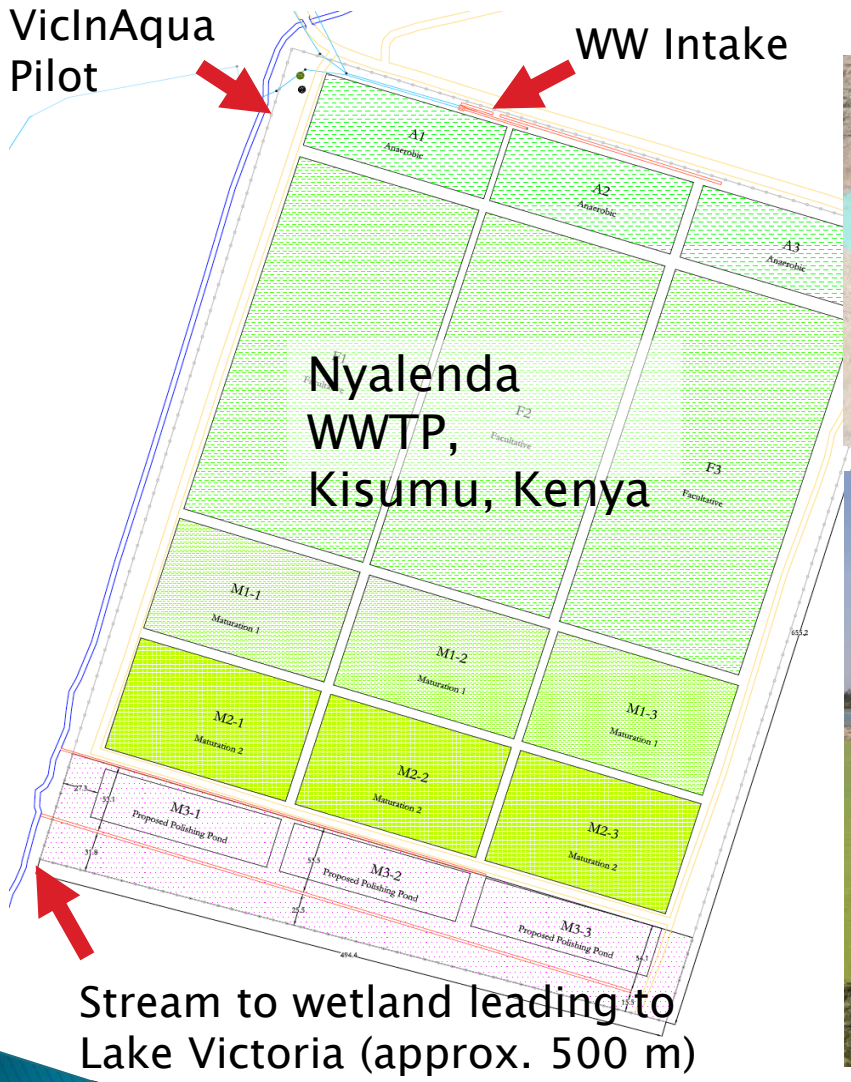
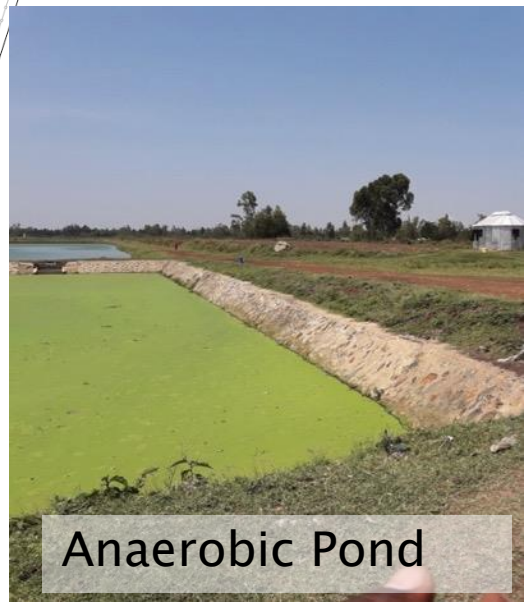
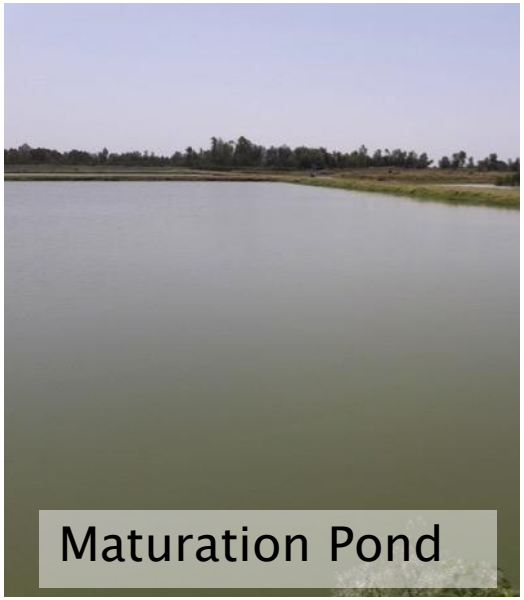
VicInAqua Pilot Plant







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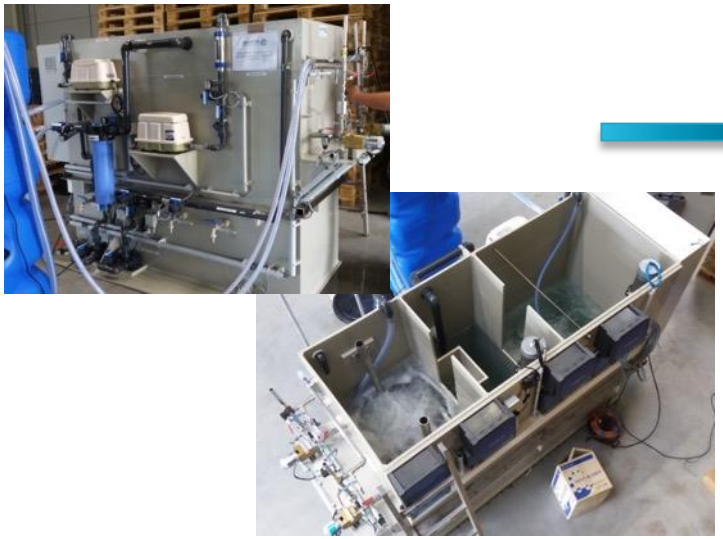
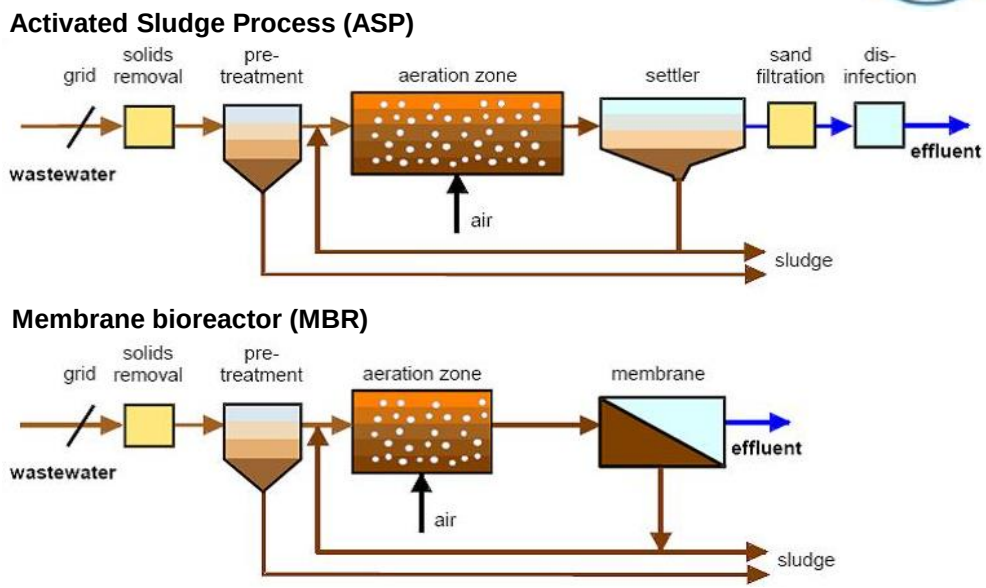
VicInAqua – Membrane bioreactor (MBR) filter technology





By Anja Drews (en.wikipedia.com) [CC BY-SA 3.0], via Wikimedia Commons

- MBR combines two water treatment steps → low footprint
  - Activated sludge process (air and biological floc)
  - Physical separation process (membrane)

- High effluent water quality due to membrane technology
  - High efficiency in degradation of organic compounds
  - Low sludge loading → low rates of surplus sludge
  - No clarifier needed
  - High MLSS → small bioreactor volume
  - Clean water, free of turbidity and very low germ level (no desinfection!) → water reuse!

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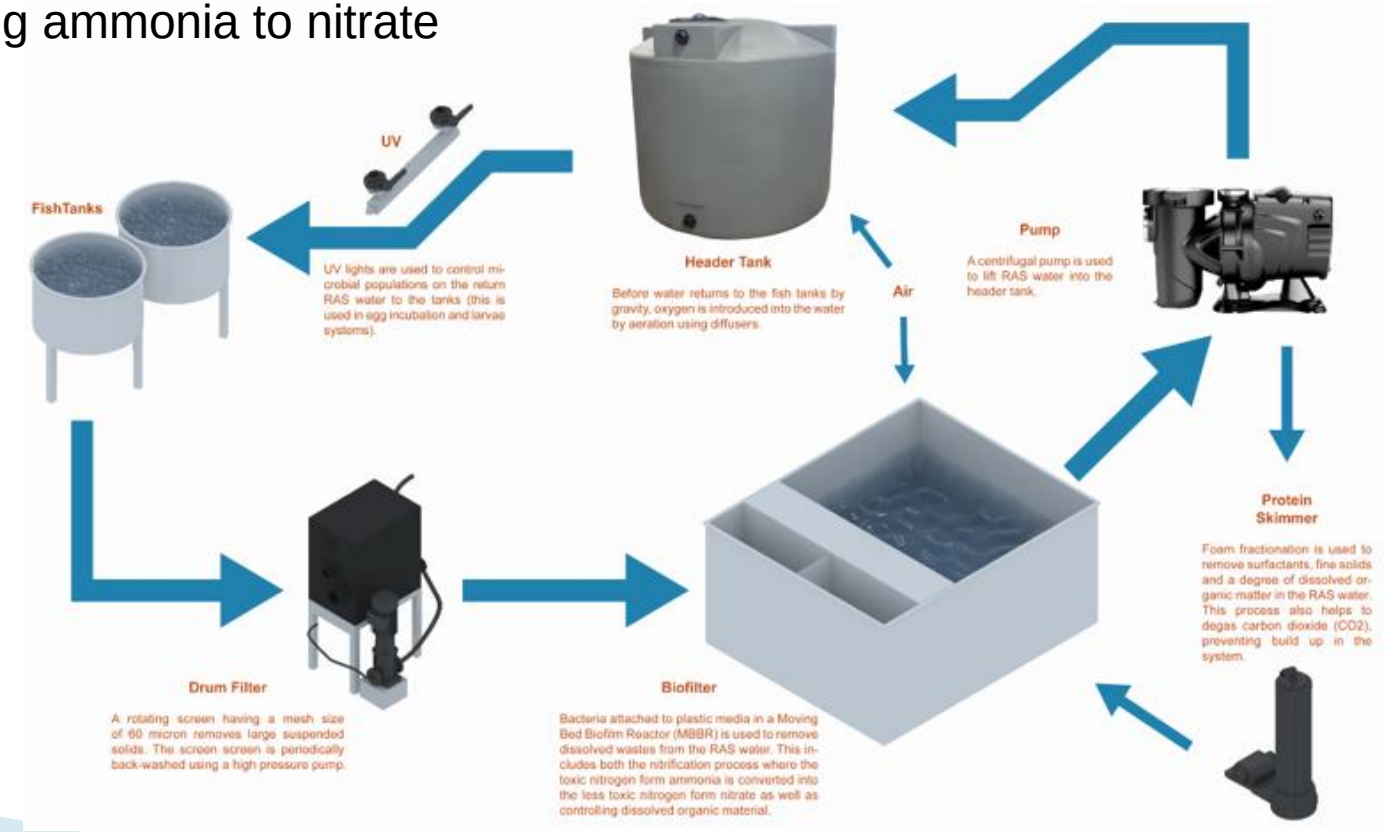
VicInAqua – Recirculation aquaculture system (RAS)

RAS Principle - Key Points

- Continuous re-use of water
- Providing oxygen to fish
- Controlling metabolites
  - Removing solid waste
  - Converting ammonia to nitrate
- Control of production environment
  - Species Optimisation
- Low water exchange rates (~5%/d)
- Accumulation of dissolved nutrients (NO_3^-)



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VicInAqua – Renewable Energy

PV Solar System

- PV solar system size 15 kWp
- Battery capacity 30 kWh
- Supply critical consumers during day and night time

Biogas Generation

- Fermentation of: Surplus sludge of MBR + cow dung + water
- Biogas (60 % CH_4), 1.69 m^3/h

Biogas digesters at the VicInAqua pilot site

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VicInAqua Impacts

In particular for the environment:

- **Effective sanitation** – Wastewater treatment (aquaculture, households, fish processing industry), solid waste management and utilisation.
- **Fresh water availability** – By avoiding release of fertilisers, antibiotics and diseases of aquaculture in the ecosystem; by reusing treated water for aquaculture and agriculture purposes.
- **Use of renewable energy** – Thereby reaching a very low CO_2 footprint and enabling autonomy to cover energy demand of **VicInAqua** facilities.
- **Assessment of the environmental impact, sustainability and life cycle analysis** - To guarantee a proper observance of environmental regulations.
- **Extraction and use of natural by-products (nutrients to be used as fertilisers)** - To be used in agriculture, thus providing a sustainable and environmentally friendly solution, which permits to take distance from chemical-based fertilisers.
- **Increase in fish production productivity** (Nile perch and tilapia) - and enabling the production of native fish species which can be step-by-step reintroduced in the Lake Victoria ecosystem.

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Thank you for your attention!!

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VicInAqua Activities

- **Get involved at www.vicinaqua.eu/get-involved/**
  - **Join our stakeholder community**
  - **Subscribe to our newsletter**
  - **Follow us on LinkedIn, Twitter and Facebook**
  - **… or drop us a message**

We are looking for partners to implement a *marketable, cost-effective* demo plant in the Lake Victoria region!

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VicInAqua – Recirculation aquaculture system (RAS)

- Pilot RAS Tilapia hatchery
- Training facility run by Kisumu County
- Capacity: 25,000 fingerlings / month (1-2 g)
- RAS A - Broodstock & Egg incubation
- RAS B - Larval rearing
- RAS C – Nursery
- RAS process - Solids removal + nitrifying reactor + aeration + (UV)
- Water exchange per day: 5 – 10% per day equal to capacity of MBR
- Exchanged water to MBR (denitrification) + blend to agriculture
- Solids to digestor
- Testing involving heavy metals & pathogens in fish after grow-out in cages or ponds

RAS A – Broodstock and Egg Incubation

Tilapia Fingerlings

Market-sized Tilapia

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VicInAqua Potential Markets

- Freshwater fish are popular diet
- Tilapia is the most popular, however, other freshwater species are also available
  - Silverfish (Omena, Mukene)
  - African catfish
  - Lungfish
  - Nile perch
- Tilapia price depends on the size (larger, >1kg fish are more preferred by the consumers) but it is around 3-5 €/kg
- Lack of cold chain in the local production
- Large volume of frozen tilapia import from China

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VicInAqua Potential Markets

Urban aquaculture: Producing market size fish close to the markets

- Needs clear borehole water and area to treat effluents
- Can be connected to agriculture or extensive aquaculture
- Selling fresh fish directly to the consumers

Hatchery production: Small and mid-scale RAS to keep broodstock, hatch the eggs and produce 1-5 g fingerlings

- To produce high quality fingerlings needs controlled environment
- Monosex population with sex reversal
- Supply of small scale pond and cage farmers

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VicInAqua Pilot Plant

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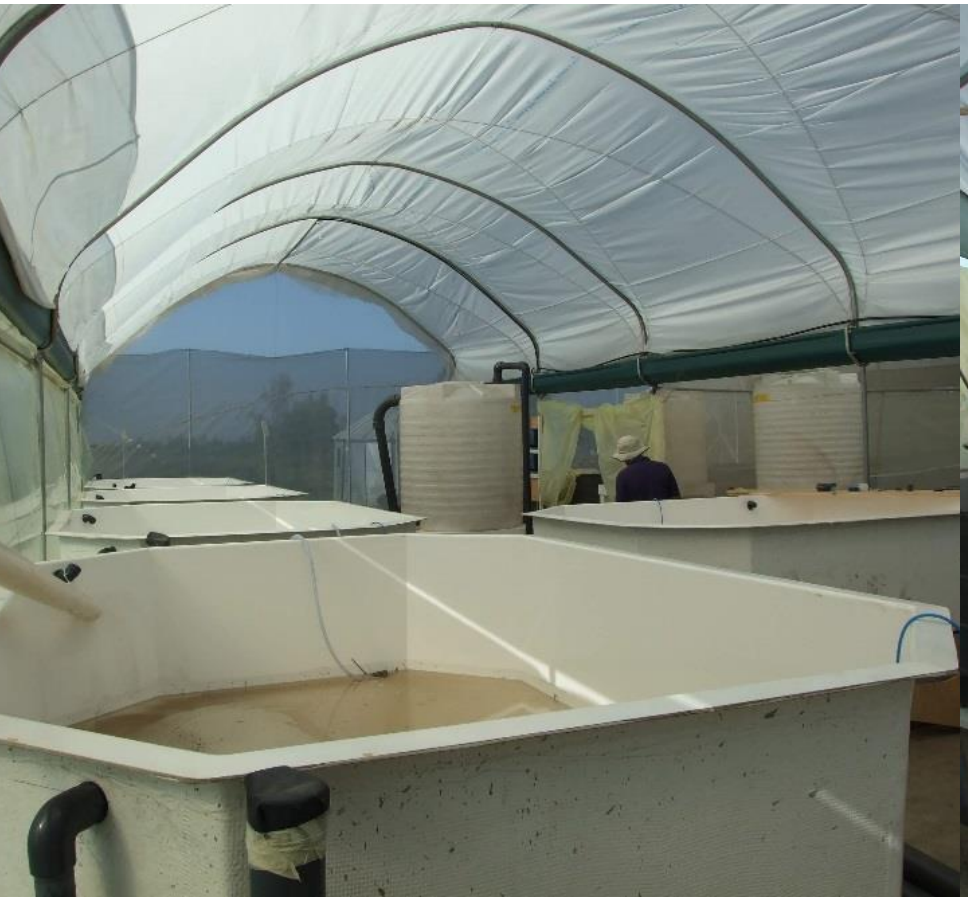
VicInAqua – RAS Pilot Installation



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VicInAqua Impacts

In particular for society

VicInAqua will also empower local stakeholders in the agro and aquaculture sectors by:

- Raising awareness on the critical relevance of environmental protection and food security.
- Providing an integral technical solution for more effective sanitation and water supply.
- Translating the knowledge gained into economical benefit and job creation.
- Encouraging women to undertake a more active role in the aquaculture sector.

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VicInAqua – Monitoring System




MEASURING, MONITORING AND CONTROL

Data from probes, levels and set points is shown and set directly on Pacific Main units and on any PC connected through LAN to Pacific web interface, or the graphic interface in the Main Pacific called “Nautilus”.

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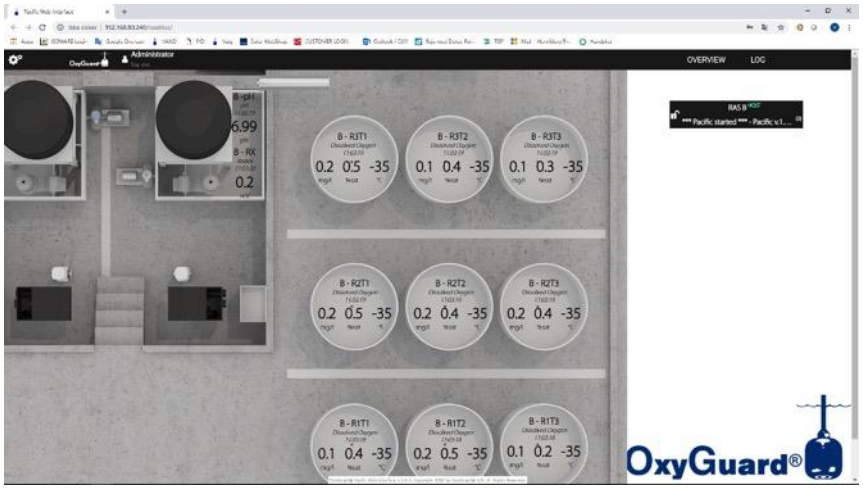
VicInAqua – Monitoring System



Nautilus graphic interface

The installed Commander box makes it possible to collect all log information into the PC connected to it, and to have all Alarms visually shown on the PC screen.

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VicInAqua Business Case

General

- Investment costs are calculated as €53,000 only the RAS technology and construction costs
- The product will be 25,000 all male fingerling in every month which can be sold on a price of 6 KSH/fingerling

Operational costs (Data from on site experience and other studies*)

- Pelleted fish feed with 15% protein for broodstock: 40 KSH/kg
- Pellet larval and fingerling feed with 30% protein: 80 KSH/kg
- Electricity: in the project part of required electricity is produced by PV panels. Average electricity costs in Kenya: 17.17 KSH/kWh. The calculated power need of the RAS units is 127kWh/day
- Water: RAS water will be cleaned wastewater from MBR. Tap water price estimated at 30 KSH/m^3
- Labour: The small system can be operated by 1 person + security guard is needed

*Ngugi, C.C., Nyandat, B., Manyala, J.O. & Wagude, B. 2017. Social and economic performance of tilapia farming in Kenya. In J. Cai, K.K. Quagrainie & N. Hishamunda, eds. Social and economic performance of tilapia farming in Africa, pp. 91–111. FAO Fisheries and Aquaculture Circular No. 1130. Rome, Italy.

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VicInAqua Business Case

Total monthly revenue of 25k fingerlings for 6KSH	150,000 Ksh/Month €1,290	
Cost item	**Monthly costs**	
Feed for 180kg broodstock biomass, calculating with 2% of body weight (BW) daily feeding rate	5,400 Ksh €46	
Feed for fingerlings calculating with 10-15% BW feeding rate per day	11,400 Ksh €95	
Personnel costs: 300 Ksh/day for security, 700 Ksh/day with taxes for technician.	30,000 Ksh €258	
Electricity IF it has to be supplied from the grid, calculating with 127kW daily consumption.	65,424 Ksh €563	
Water costs IF the system use 4.35 m3/day new water from the pipeline	3,915 Ksh €34	
Other costs: chemicals, repairs, services	4000 Ksh €34	**Monthly profit**
Total monthly costs WITH water and electricity	**119,779 Ksh €1,030**	**30,221 Ksh €260**
Total monthly costs WITHOUT water and electricity	**50,440 Ksh €434**	**99,560 Ksh €856**

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