ALGAEUROPE CONFERENCE 2015

EABA EUROPEAN ALGAE BIOMASS ASSOCIATION

European Commission

BENELUX

ABG AlgaeBioGas

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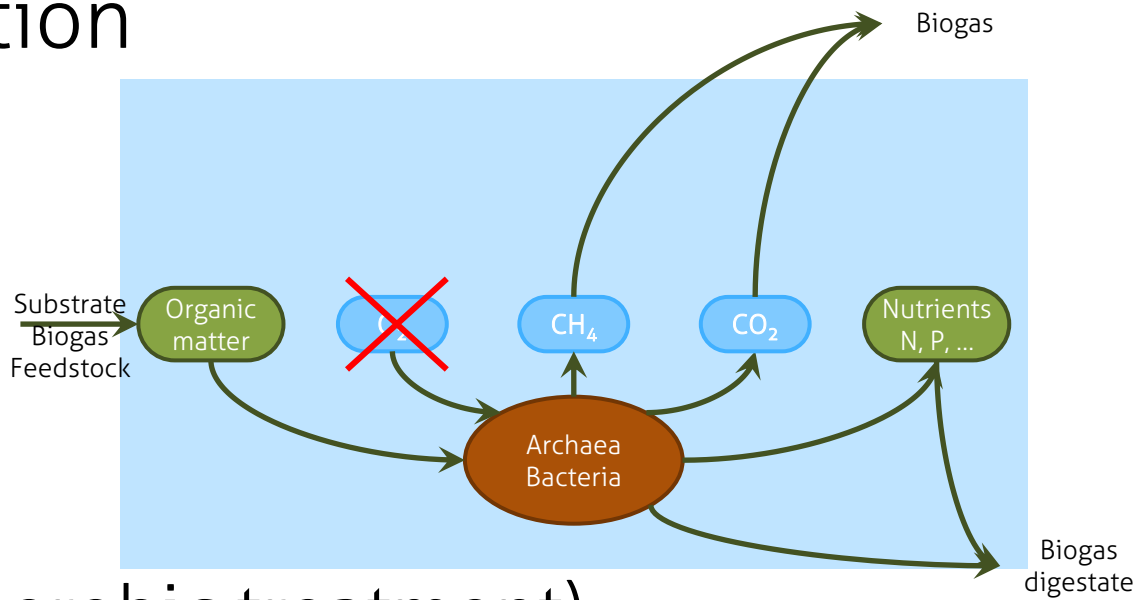
Agenda

- Introduction to biogas
- Algae and biogas: **recycling nutrients** and CO_2
- Algal-bacterial **treatment** of biogas digestate
- Algae as biogas **feedstock**
- AlgaeBioGas project

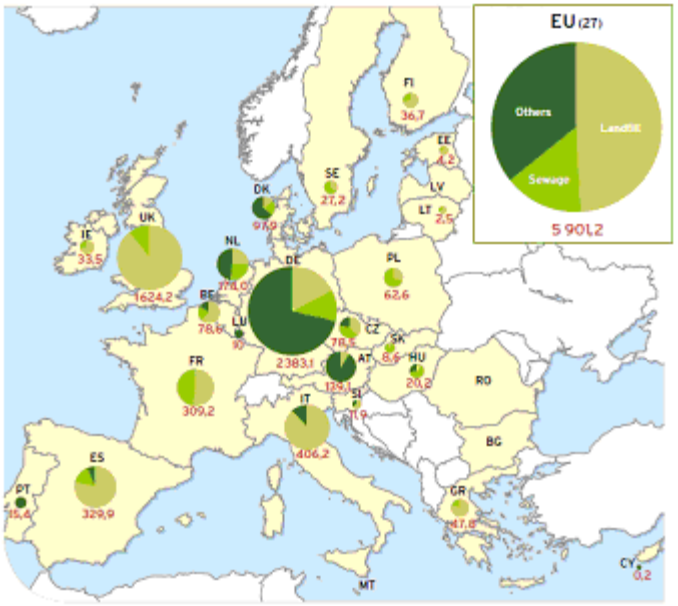
Biogas

- Anaerobic digestion
- Many flavours:
  - Landfill gas
  - Wastewater sludge
  - Bio waste
  - Wastewater (anaerobic treatment)
  - Agricultural waste
  - Energy crops
- Biogas is the most (area) efficient biofuel



Biogas plants

- Different technology levels
- Mesophilyc / thermophilic
- Biogas use
  - Heat
  - Combined heat and power (CHP)
  - Gas networks (enriched biogas)
- Legislation & subsidies
  - Gas grid ↔ CHP
  - Waste ↔ energy crops
  - Access to power grid
  - Nitrogen vulnerable zones



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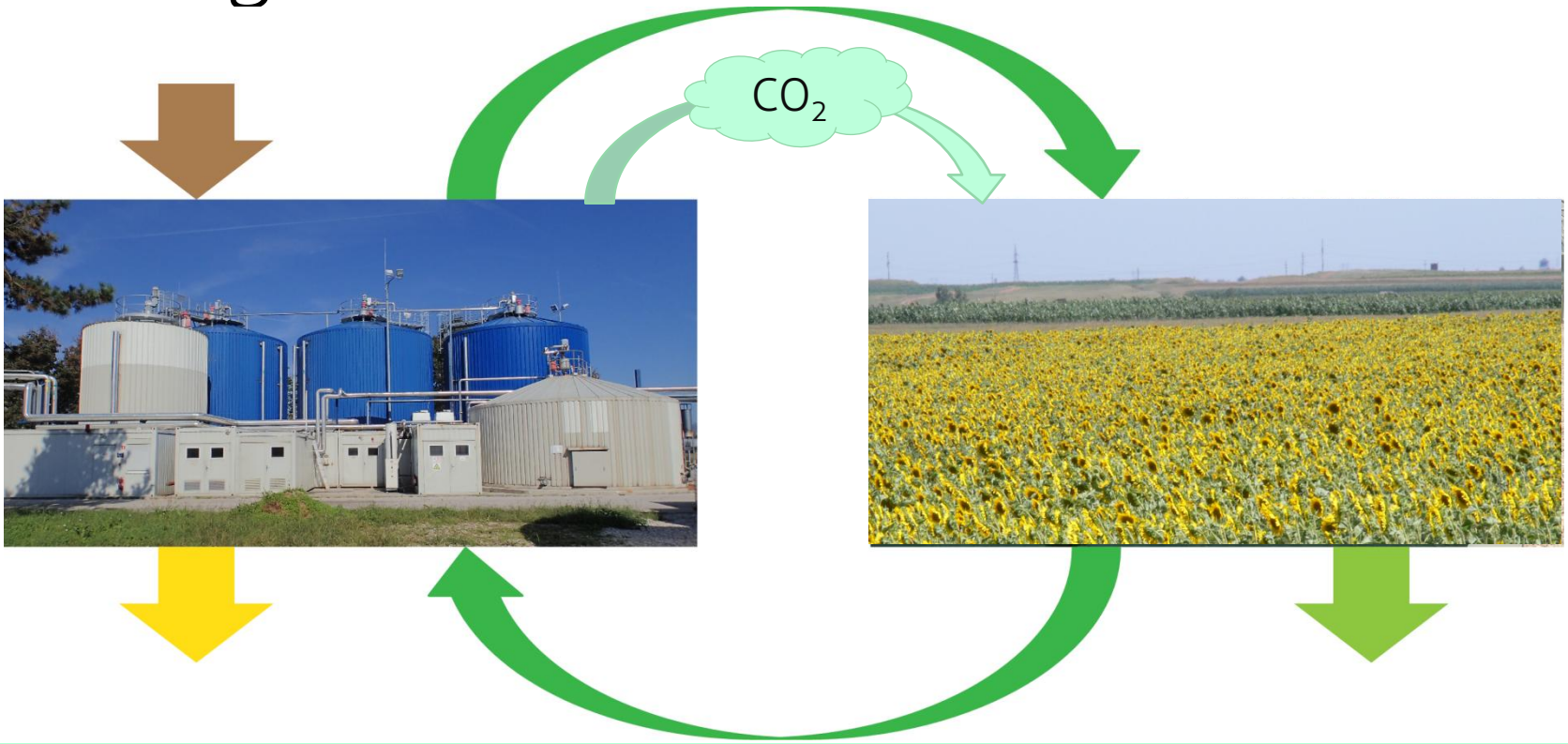
Biogas digestate

- Ideally: all organics consumed
- Ideal agricultural fertilizer



Biogas digestate

- In reality:
  - Very dilute (80-100 m^3/ha)
  - Logistics
    - Storage
    - Transportation
    - Machinery
  - Agro-technical problems
    - Liquid
    - Nutrient flushing from soil
- Separation to liquid and solid phase
  - Solid – like ordinary fertilizer
  - Liquid – wastewater, limited application to soil
- Waste, end-of-waste directive, control & monitoring

Liquid biogas digestate

- One of the hard-to-treat substances
- COD 8000 – 50000 mg O_2/L
- Classical WW processing (3 – 20 €/m^3)
  - Energy consuming conversion or organics and nutrients to CO_2 and N_2
  - Loss of energy and nutrients
- Alternatives:
  - Drying
  - Ultrafiltering
  - Reverse osmosis
  - …
- Algal treatment

AlgaeBioGas Basic Cycle

digestate as
source of nutrients

CO_2

biogas
heat & power

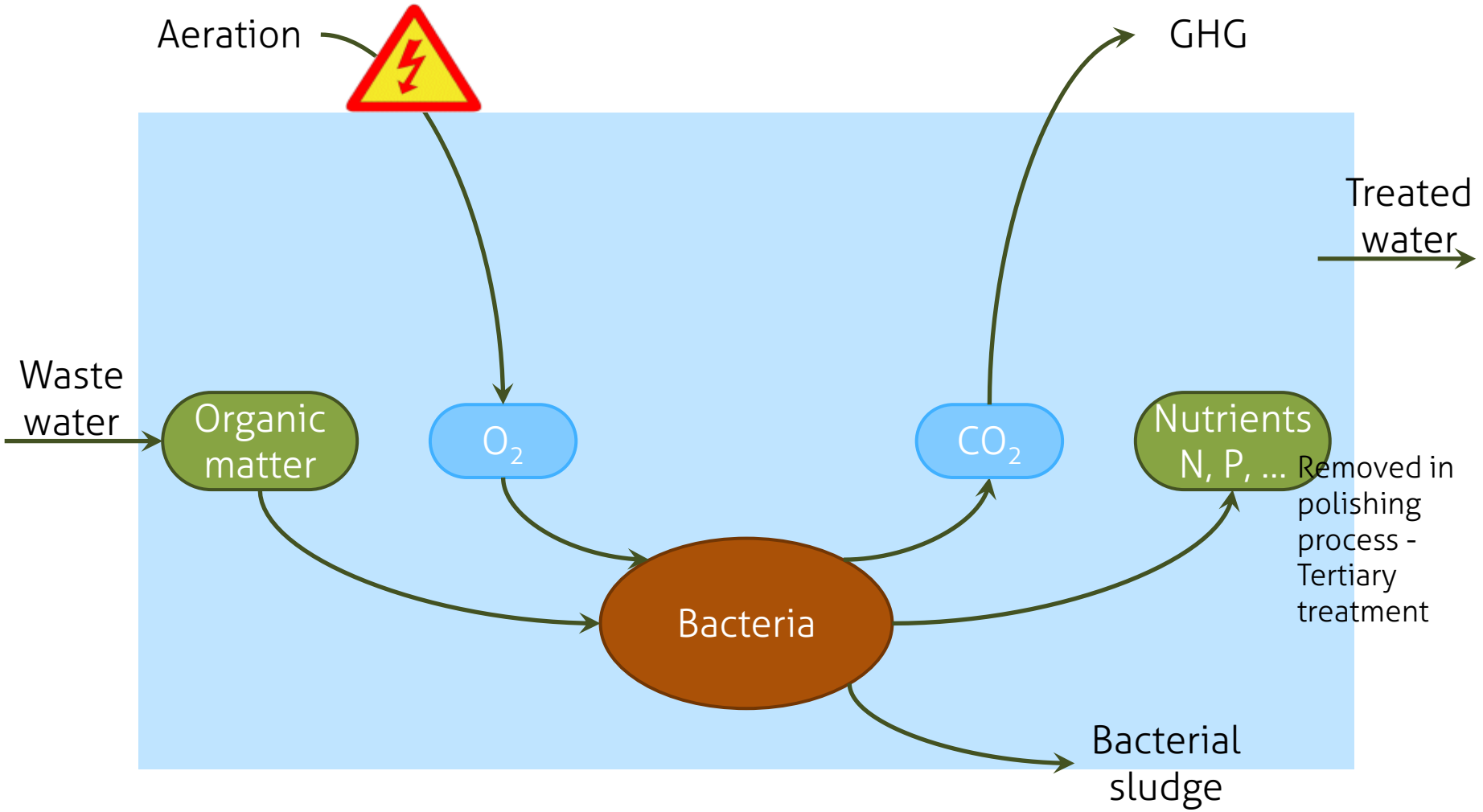
algal biogas
substrate

algal products

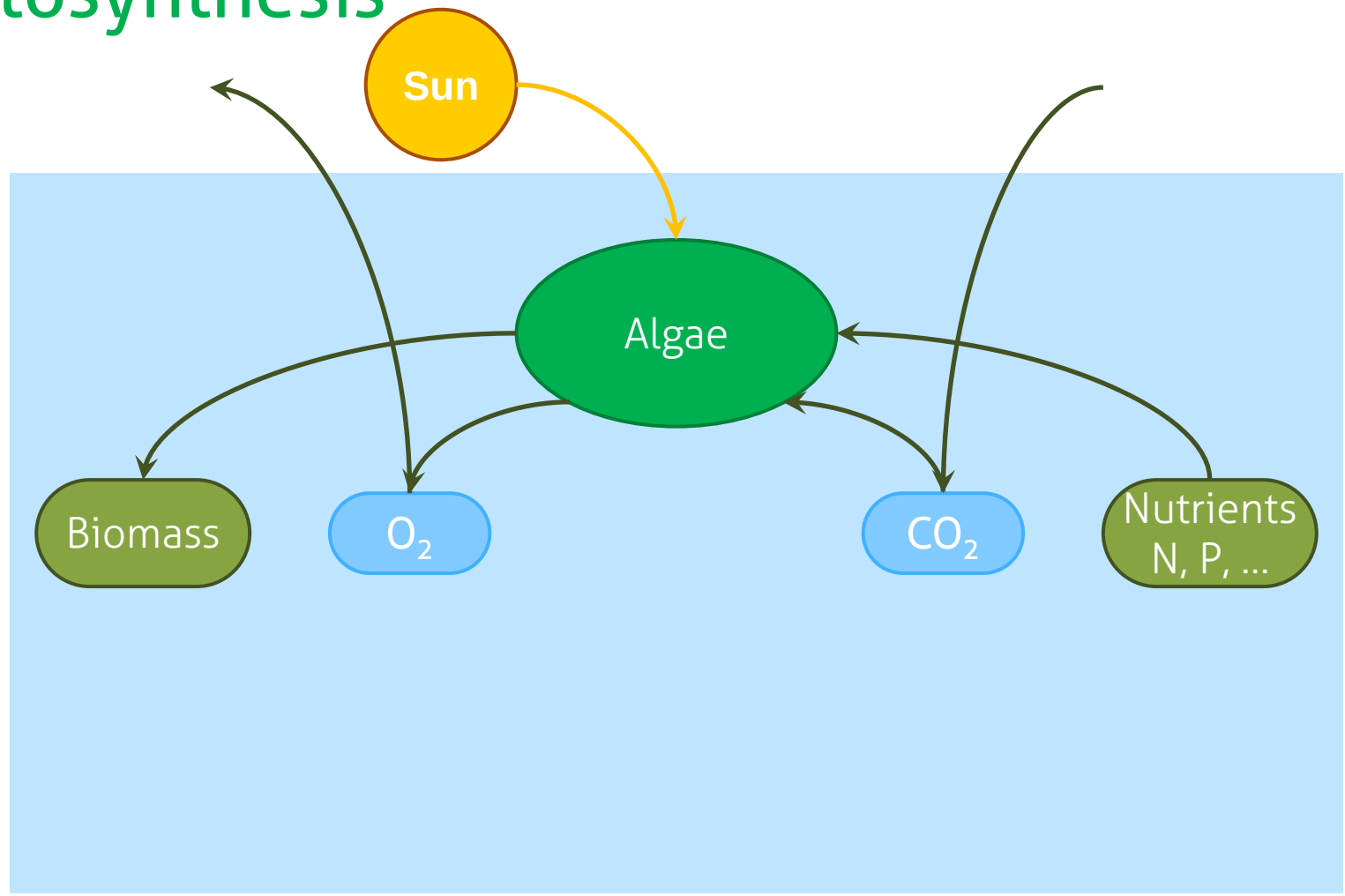
Optimizations

- Digestate treatment
- Feedstock production
- Algae production

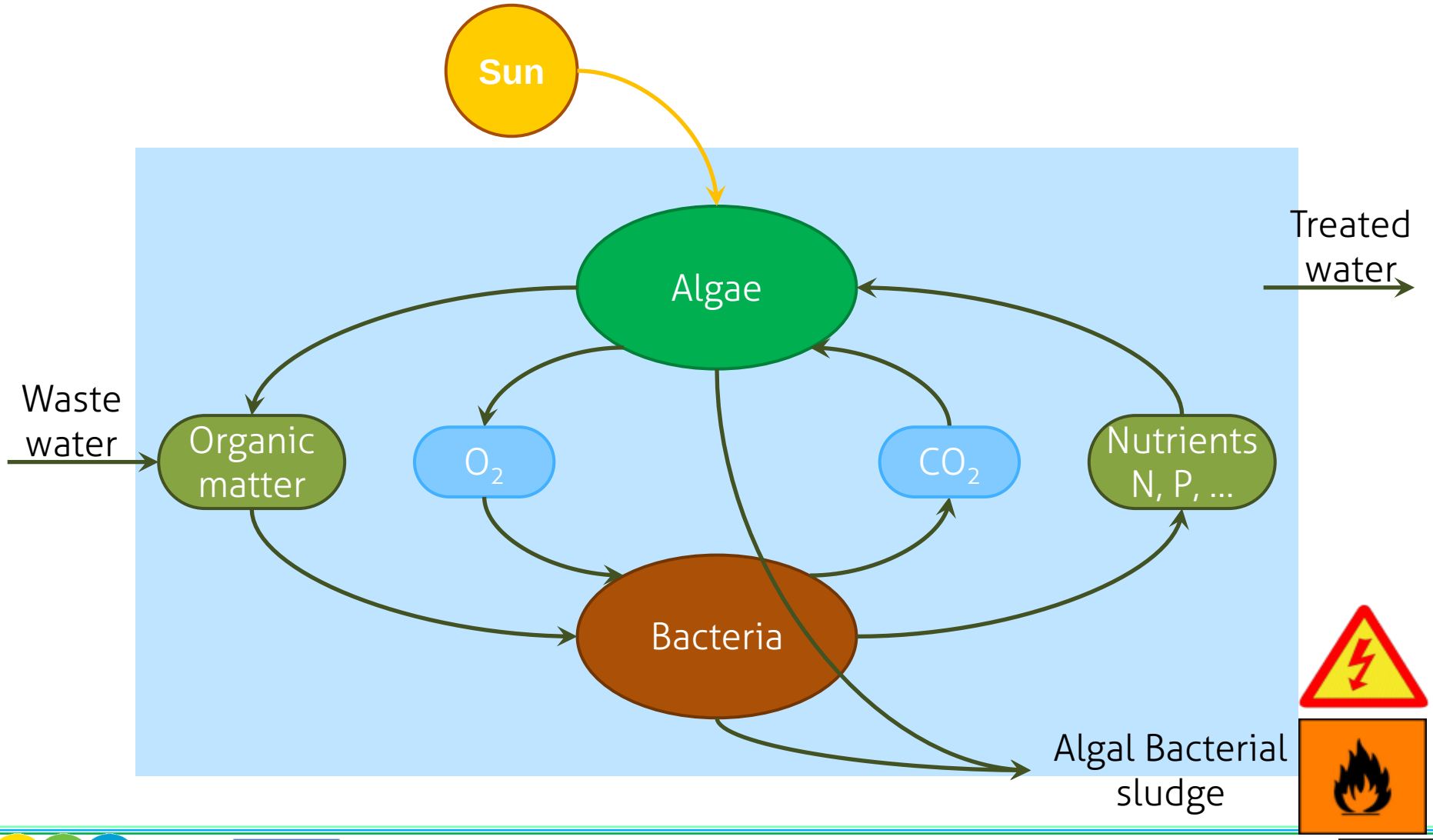
Algal bacterial process
Biological Wastewater Treatment



Algal bacterial process
Photosynthesis



Algal Bacterial (ALBA) Wastewater Treatment



Algal bacterial WWT (ALBA WWT) ideas

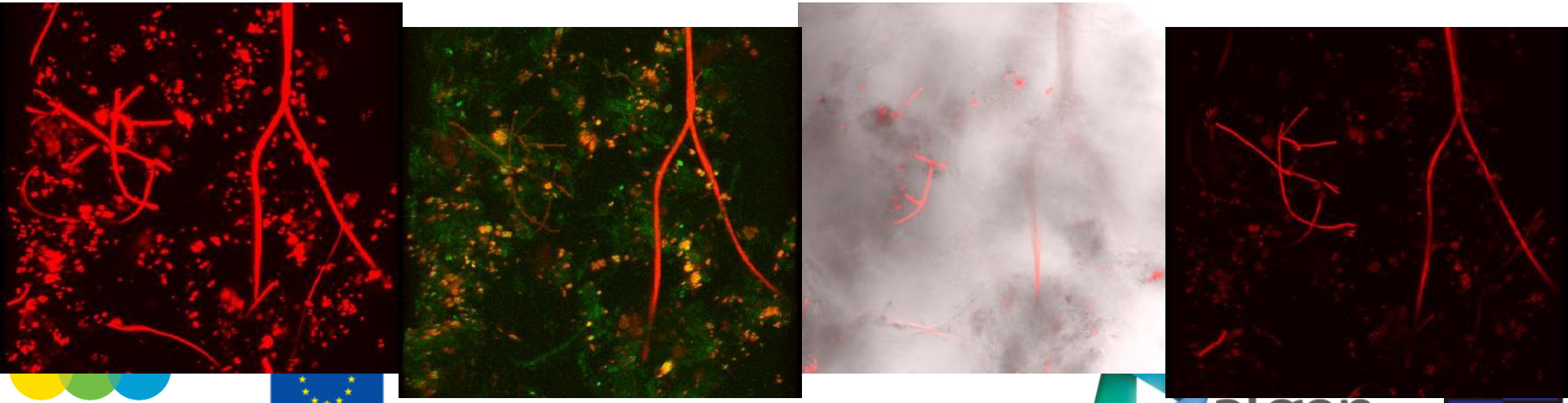
- at least 55 years old (e.g. Oswald 57)
- lagoon treatment
- shifting objectives in the past
- purpose of algal biomass
- algae : bacteria - C : N
- more diverse microbial community → less sensitive to sudden changes (antibiotics, biocides, salt, …)

A research topic of today

- No state of the art universal solutions
- Algae bacterial community is unstable
- Needs to be tightly controlled
- Digestate may be black – no light for algae
- Removal of heavy metals, accumulated toxic substances, salt, …
- Should be independent of weather

Many open issues

- dark – light sections
- how long good oxygenation lasts?
- floc ecology
- Auto-flocculation
- how to control the microbial composition (algae-bacteria balance)



Optimization for biomass production

- Larger area
- Longer retention time
- More diluted digestate
- CO_2 introduction
- More algae, less bacteria

Algae as biogas substrate

- Hard to digest
- C : N ratio
  - high C substrate should be added (i.e. cellulose)
- Pretreatment required
  - Heating, enzymatic, fungal, bacterial, ultrasonification, pressure shock, …
- Thermophilic process optimal
- If done properly biogas productivity comes close to corn silage (based on dry weight)
- Depends on species & composition

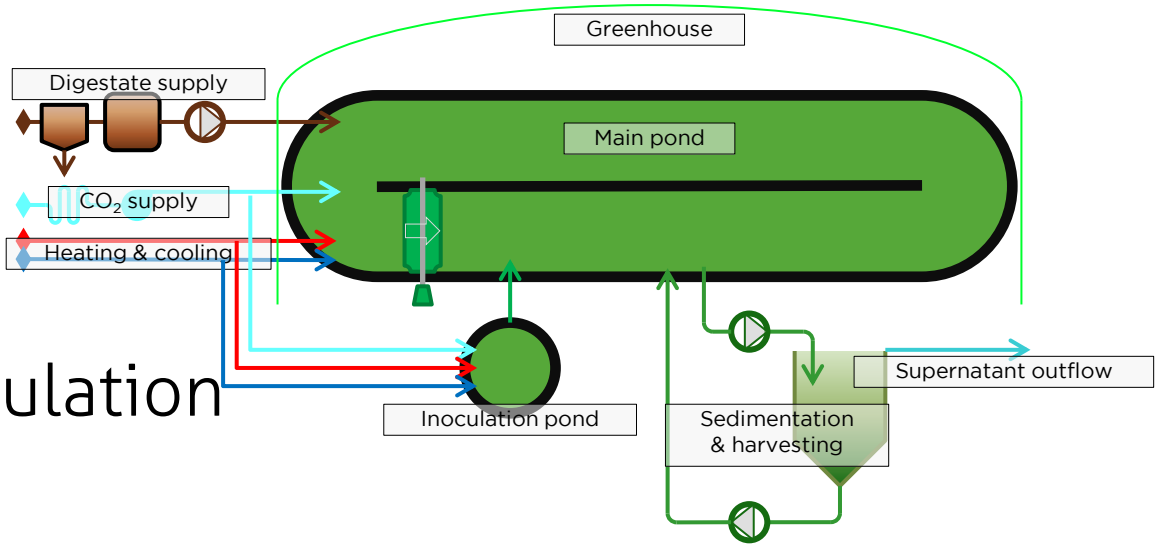
AlgaeBioGas Project

- Algal treatment of biogas digestate and feedstock production
- An Eco-Innovation project (CIP-EIP-Eco-Innovation-2012)
- Pilot and market replication project
- Two partners:
  - AlgEn, algal technology centre,
  - KOTO, biogas operator, animal waste treatment facility both in Ljubljana, Slovenia

AlgaeBioGas Objectives

- Objectives:
  - Demonstration centre design, construction, operation
  - Prepare technology for replication
  - Market development activities
- Now in Month 27:
  - Demonstration centre operational
  - Legislation analysis, LCA, business planning
  - Complementary technologies being tested
  - Technical development (controls, ponds)
  - Presentations & visits

Subsystems



- Ponds: main & inoculation
- Mixing equipment
- Greenhouse
- Heating & cooling
- Exhaust gas supply (cooling, purification)
- Digestate supply (separation, anaerobic filter, storage)
- Sedimenter/ clarifier & recycling
- Control system

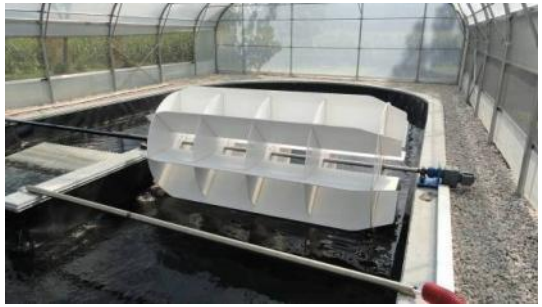
Location

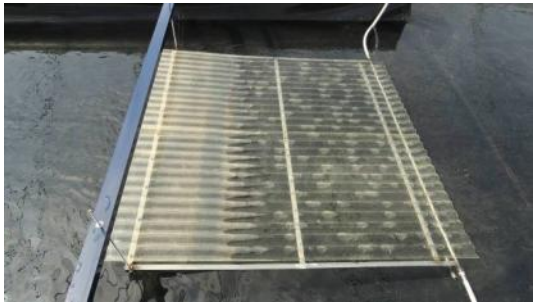

Biogas plant
AlgaeBioGas
Biofilter
CHP
Gas motor
Heat exchanger
WWT plant
Digestate separation
Image © 2014 DigitalGlobe

Before construction

Greenhouse, ponds, mixing, CO_2





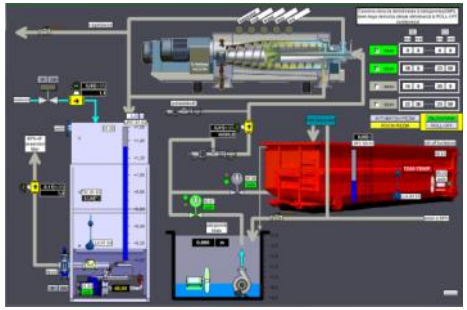

Digestate preparation

Control & instrumentation










Observed performance (digestate treatment)

- Model **biogas CHP with 1 MWe**
- to recycle major part of nutrients
  - area 3 - 5 ha
  - volume 3000 – 17000 m^3
  - 60 – 200 t algae bacterial biomass p.a.
  - use approx the same amount of waste paper pulp
  - replacing 120 – 400 t dry mass of corn = 360 – 1200 t of corn silage
  - replacing 8 – 26 ha of corn fields

Future

- Preparation for market replication
- Life Cycle Assessment
- Complementary technologies:
  - Digestate pre-treatment
  - Auto(bio)flocculation, DAF
  - ALBA biomass pre-treatment for biogas
  - Animal feed trials (fish, chicken)
- Technical & manufacturing
  - More cost-effective
  - Better performance
  - More control
- **Partners**: marketing & implementation service
- **Ready for second replication (at an early-adopter site - challenge us)**

Thank you for your attention

- Questions?

- Welcome to visit the ABG AlgaeBioGas demonstration centre.