Large scale cultivation, storing and refining of seaweed

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Who is ECN?

Energy research Centre of the Netherlands (ECN)

- What do we do:
  - ECN develops market driven technology and know-how to enable a transition to sustainable energy society

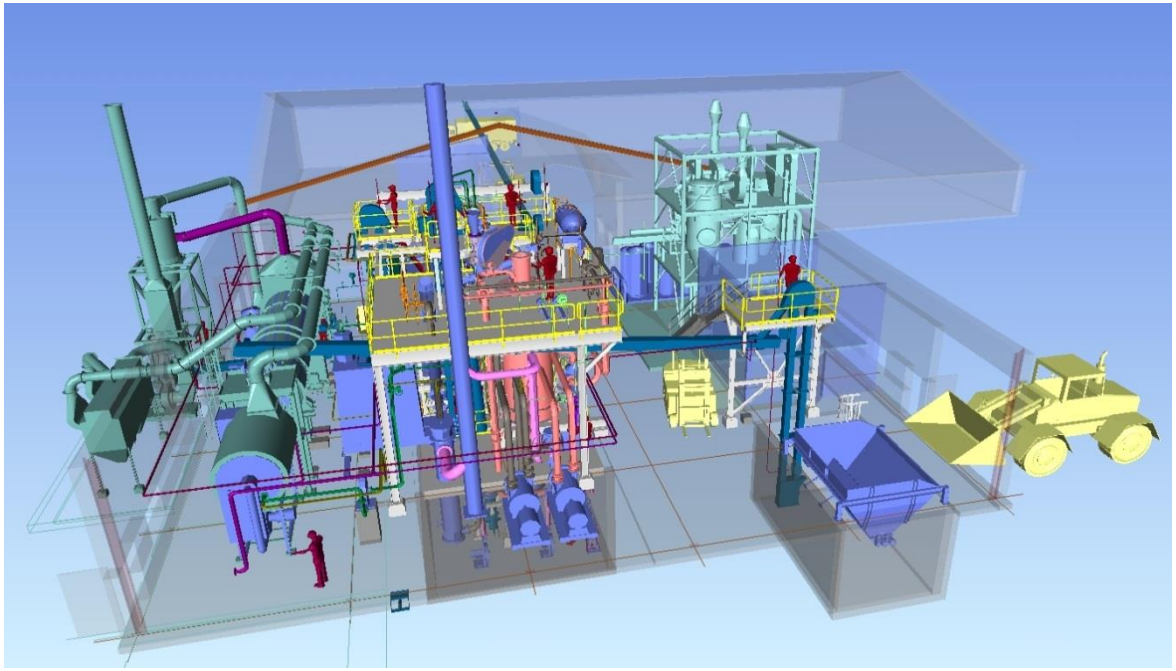
- Business units:
  - Biomass & energy efficiency
  - Solar energy
  - Wind energy
  - Policy studies
  - Environment & energy engineering

ECN

- Independent research institute
- ~600 employees
- Locations:
  - Petten (HQ)
  - Amsterdam
  - Eindhoven
  - Brussels
  - Beijing

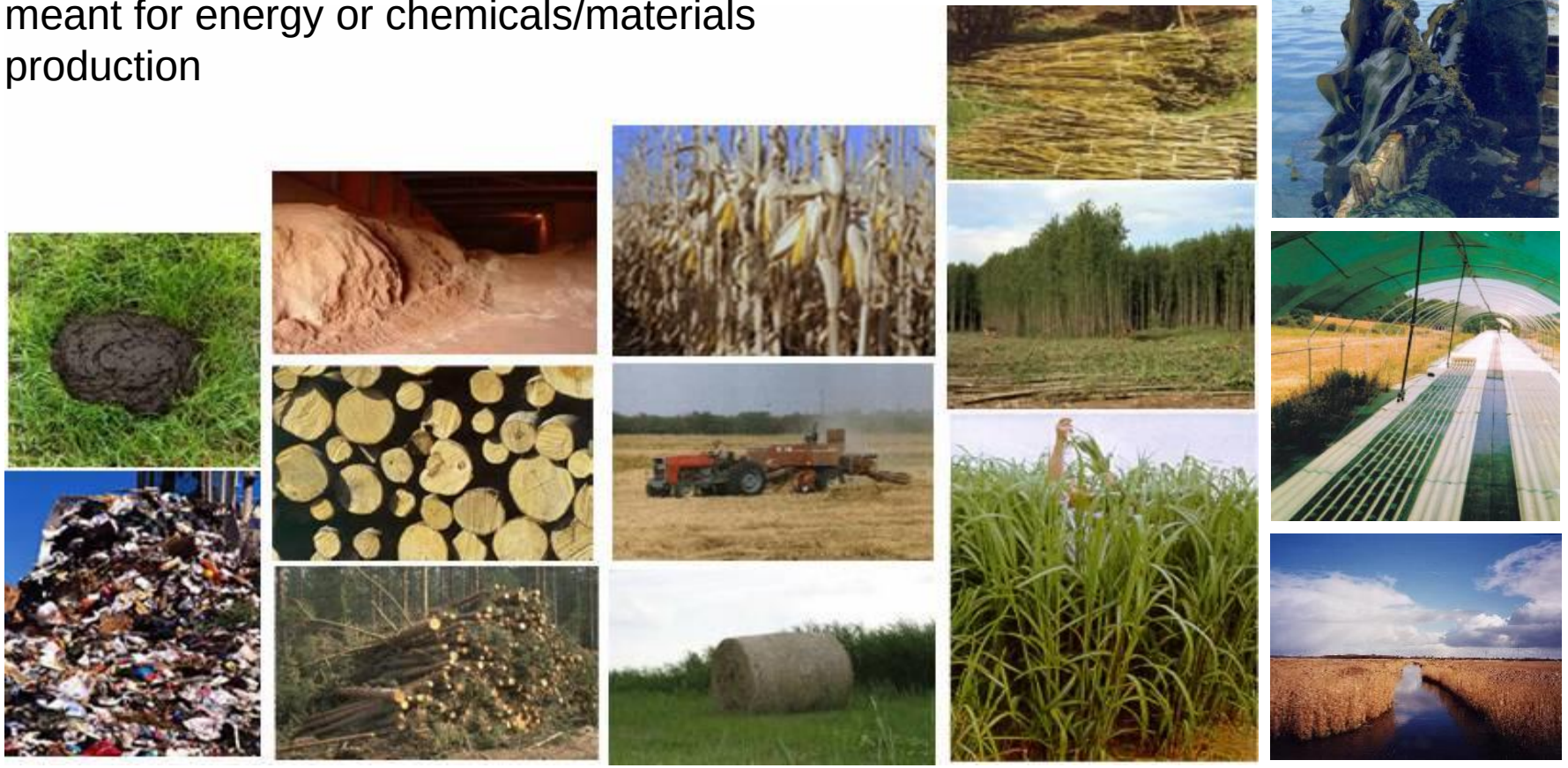
Biomass Pre-Treatment Licensees, clients

- Torrefaction technology
  - Demo plant operational



Biomass – a diverse energy source

- Biomass = all organic material of non-fossil origin meant for energy or chemicals/materials production



waste wood (agricultural) residues energy corps aquatic biomass

Bio-Offshore

- Seaweed cultivation area 5.000 km2 (<10 % of the NL area of the North Sea @ 57.000 km^2)
- Integration with off-shore wind parks & (other) aquaculture operations
- Energy potential up to 350 PJ_{th} (25 Mton dry biomass per year)
  - All Dutch households
  - All gasoline and jet
- ECN-C—05-008

Current initiatives

- Crown Estate, 15,000 km^2 for biogas production
- Denmark, MAB3
- France, seaweed for biogas project
- Norway, Statoil initiative (seaweed to ethanol)
- India, national seaweed initiatives (seaweed to ethanol)
- South Korea, seaweed to ethanol initiative
- EU, use seaweed for biofuels
- US: PNNL-Canadian initiative
- Etc.

Cultivating seaweed

Seaweed species native to the North Sea

Saccharina latissima

Laminaria digitata

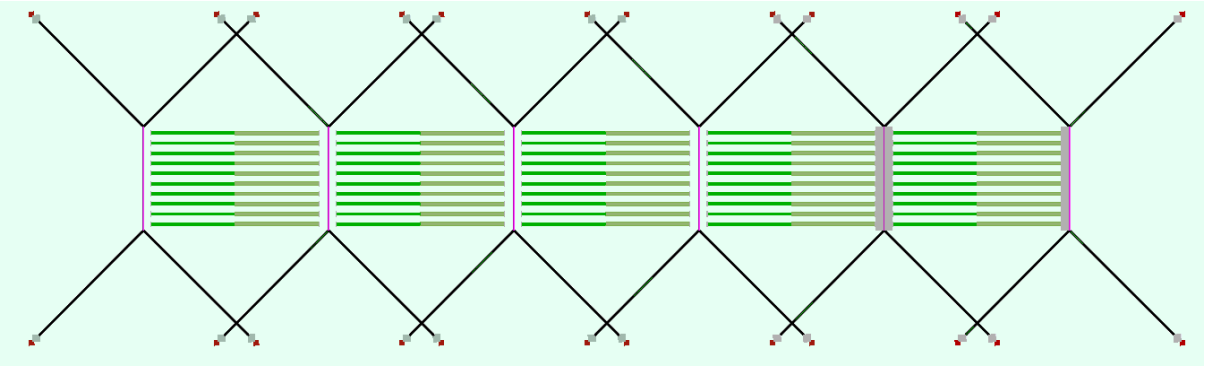
Laminaria hyperborea

Ulva sp.

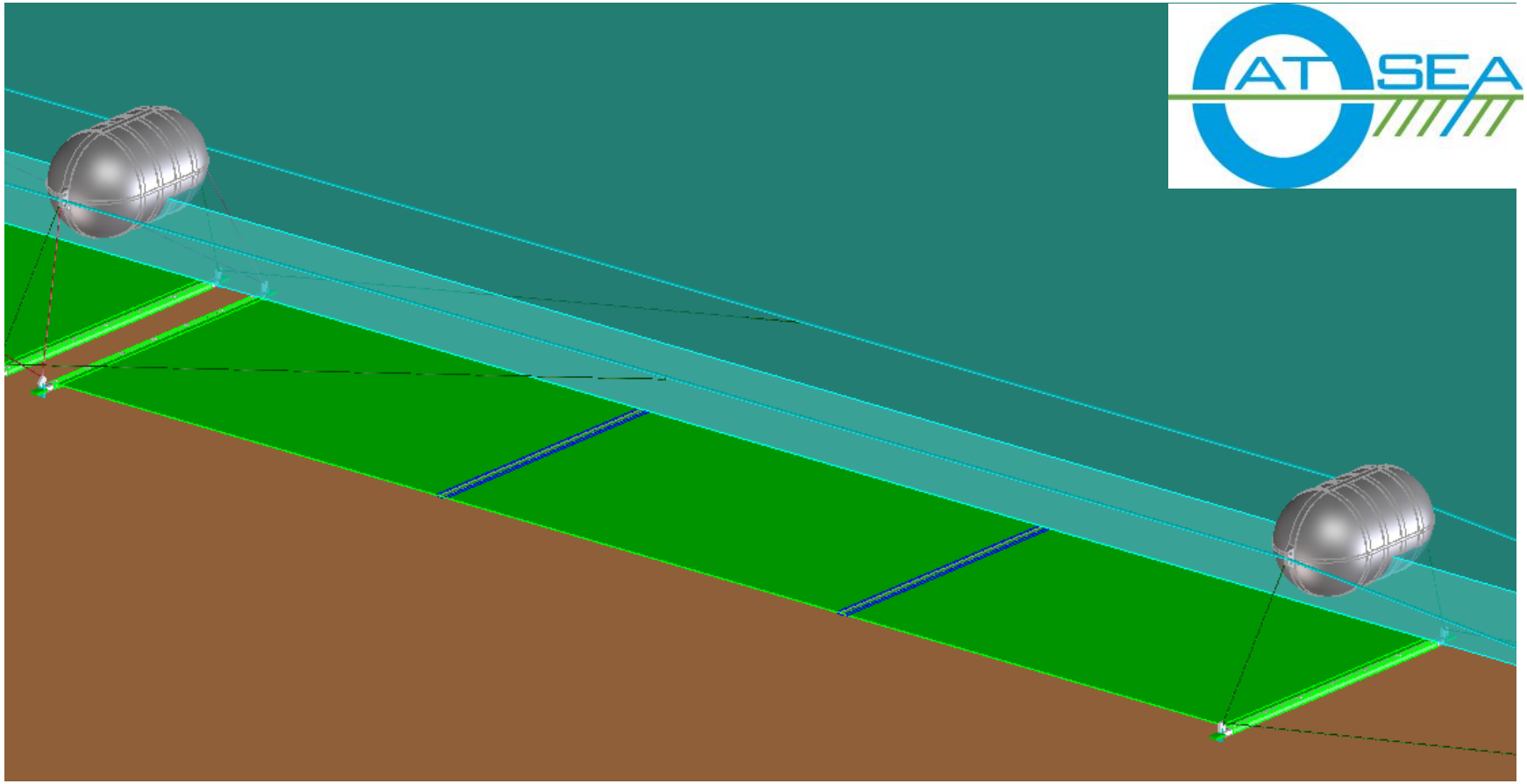
Alaria esculenta

Palmaria palmata

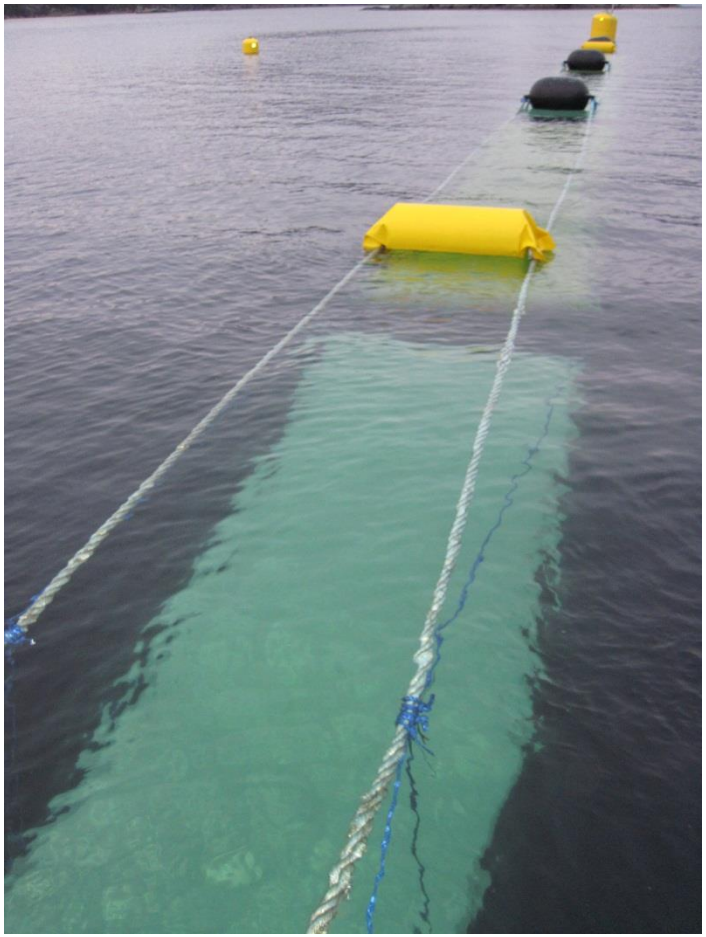
Conceptual cultivation system



Detailed artist impression



Deployment and harvesting



Storing seaweed

Initial experiments

- Fresh Seaweed

- Stored Seaweed

Experiments

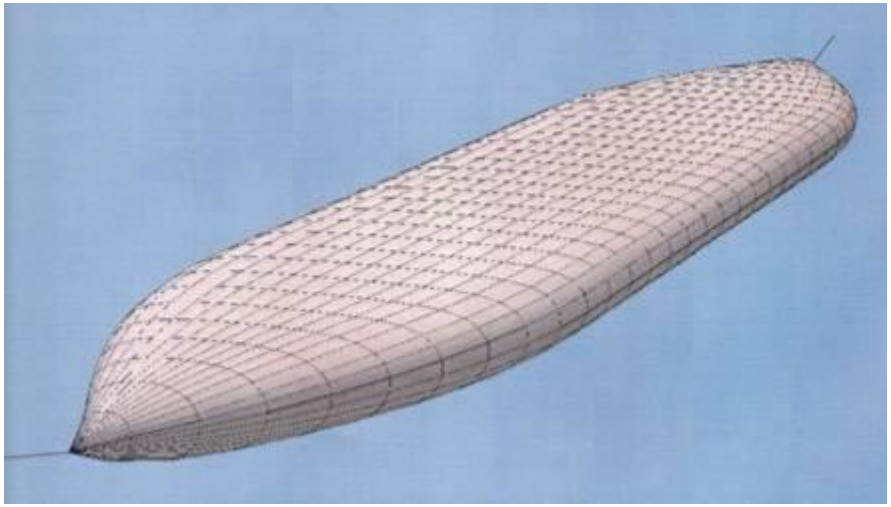
- Seaweed stored under N_2 at 15+/- 1°C
- Samples at Day 1, 2, 3, 7, 14, 21, 28, 25, 49, 63, 77, 88
- Samples freeze dried at analyzed for main sugars (mannitol, glucose, galactose) at 28 days
- Allows to see which concepts works

Results

- Pureed stored seaweed

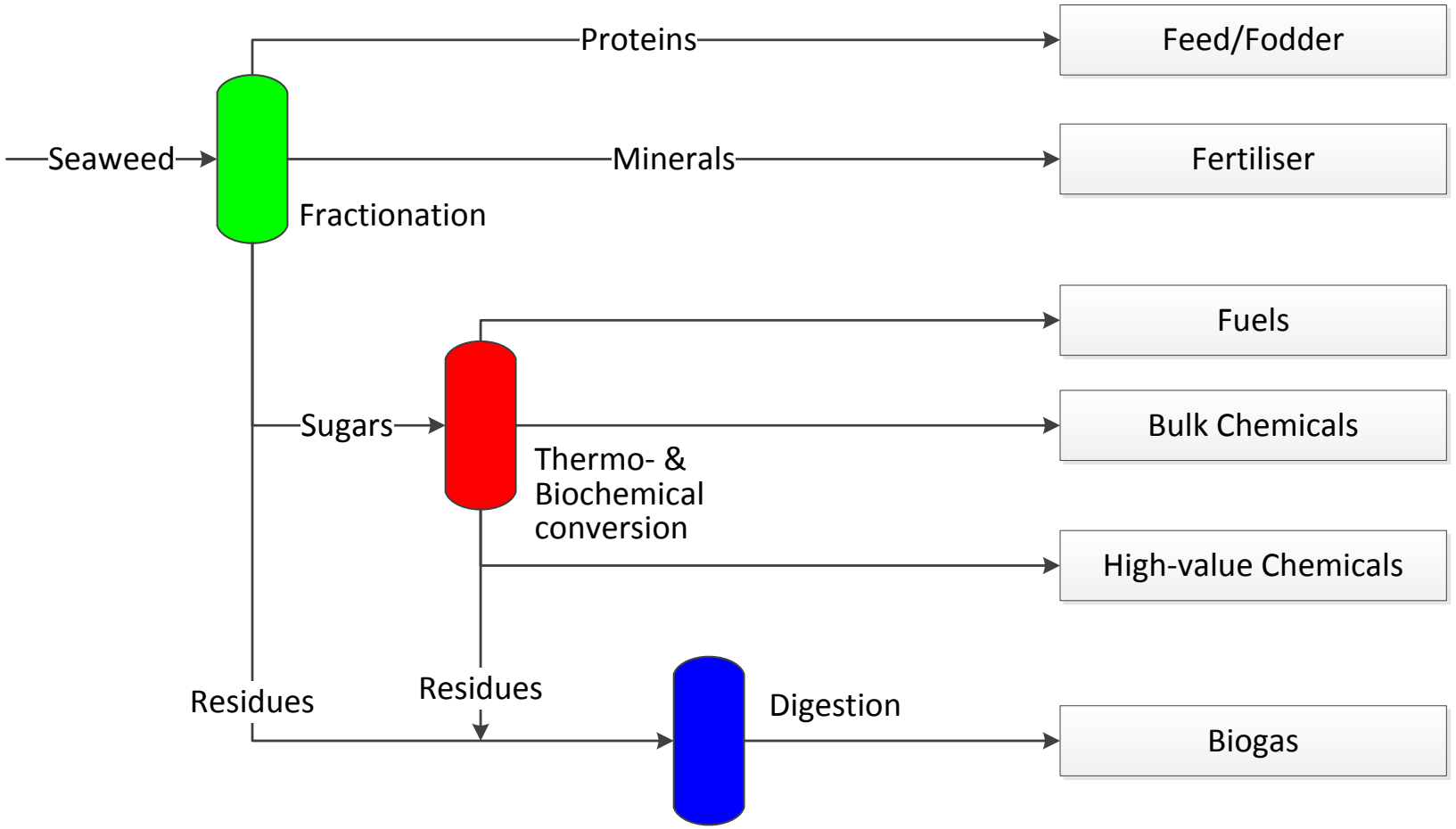
- Cut stored seaweed

Large storage at sea



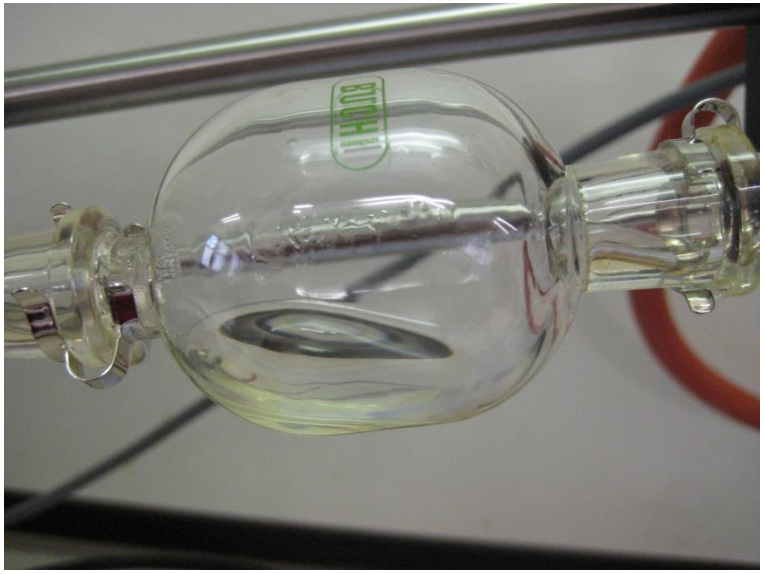
Fractionating seaweeds

Seaweed biorefinery



Crude carbohydrates and isolated mannitol

Synthesis of iso-mannide



Applications of iso-mannide

- Isomer of iso-sorbide
- Interconvertible into other isomers
- Separation based on boiling point possible
- Intermediate for
  - Plasticizers
  - Fuel additives
  - PET replacements
  - Epoxy resins
  - PUR

- Prepared isomannide from fresh seaweed!

Questions?
For more information

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