



Energy research Centre of the Netherlands

# Seaweed: the other algal biomass

**Jaap W. van Hal**

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# Seaweed: the other algal biomass

Jaap W. van Hal



## Parts of seaweed plant



Blade

Stipe

Holdfast

## Does not compete with food





## No land use issues



## Bio-Offshore

- Seaweed cultivation area 5.000 km<sup>2</sup> (<10 % of the NL area of the North Sea @ 57.000 km<sup>2</sup>)
- Integration with off-shore wind parks & (other) aquaculture operations
- Energy potential up to 350 PJth (25 Mton dry biomass per year)
- ECN-C—05-008



## The US exclusive economic zone



About 12M km<sup>2</sup>, could produce 5 billion tons of dry biomass



## Why seaweeds

- Does not compete with food
- Does not compete with any other land use
- Grows in cold seawater
- The fastest growing biomass at our latitude
  - The Netherlands is as far north as New Foundland
- Biochemical composition: complementary (for fuel/chemicals production) to micro-algae
  - Comprised of carbohydrates, protein and ash



Foto: M. Bartosch

# Petten: energy research campus



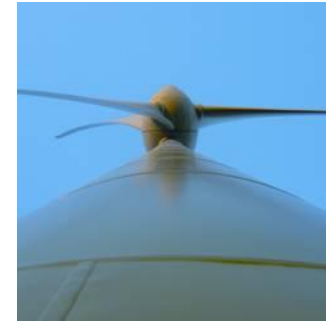
# R&D units



Solar energy



Biomass



Wind energy



Efficiency &  
Infrastructure



Policy  
Studies

## Sustainable energy technology to the market

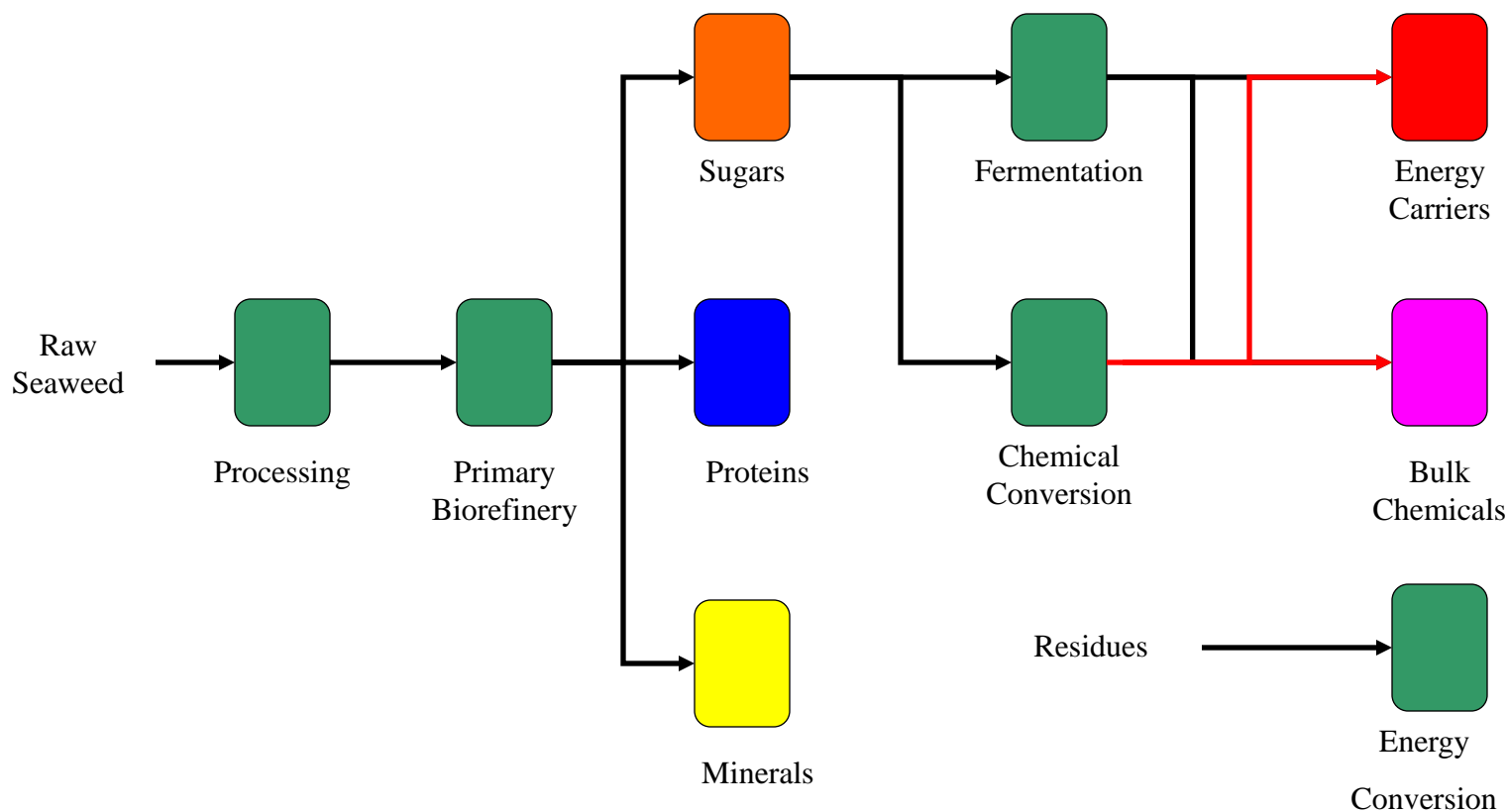
- Bivkin, gasifier
- Olga, tar removal
- Green Gas and CHP (Milena, Olga)
- Torrefaction demo and commercialisation
- Marga aerosol and gas sampler
- Automatic Colum leaching test

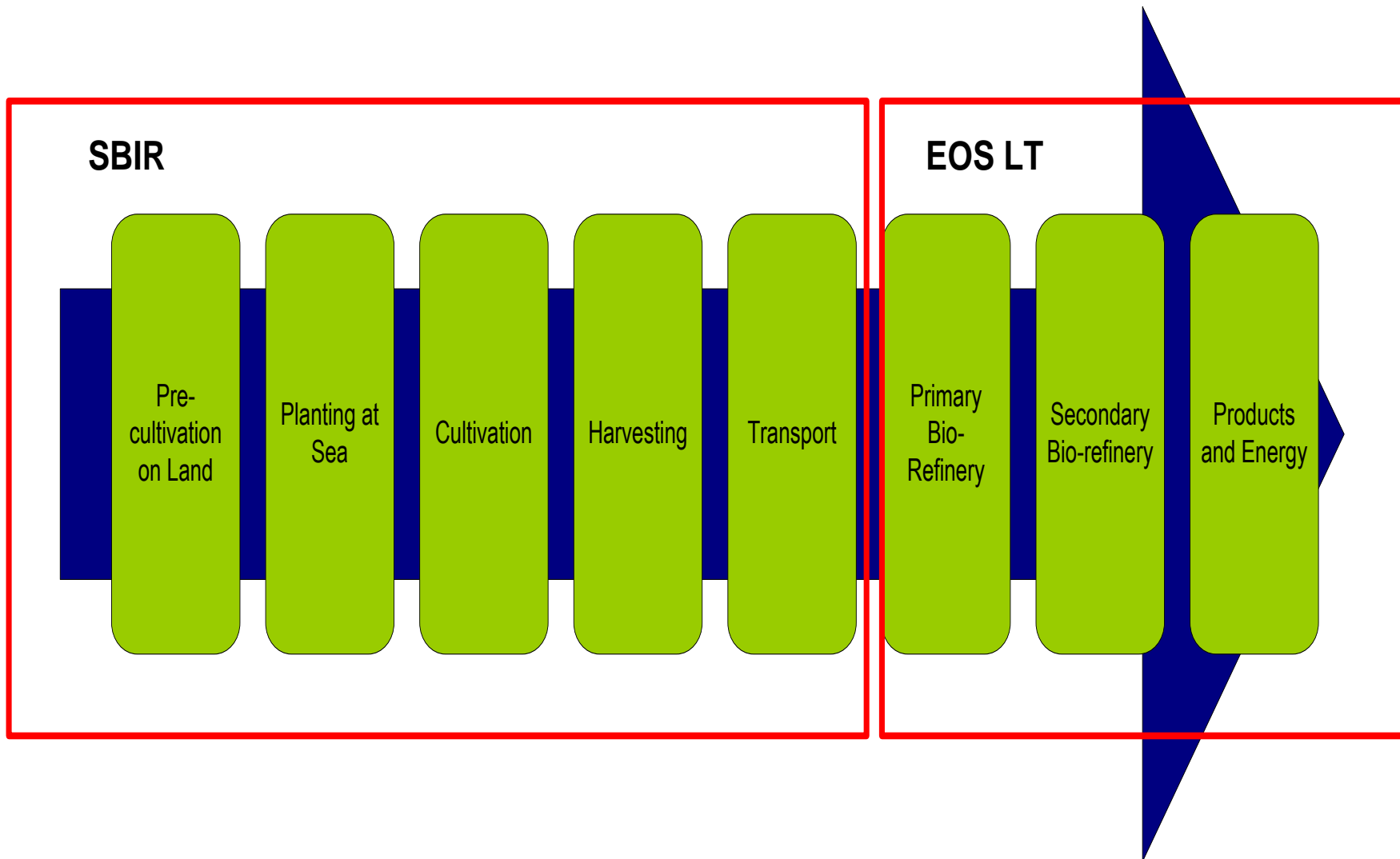


## **National research project: seaweed biorefinery (EOS LT 08027)**

- ECN (Project coordinator)
  - Irish Seaweed Center
- Wageningen University Food and Biobased Research (WUR-FBR)
- Wageningen University Plant Research International (WUR-PRI)
- ATO-NH (Technology transfer company)
- Process Groningen BV (Digestion)
- Project 1-9-09 until 1-9-2013

# Seaweed biorefinery process concept







## Potential Applications

- Furanics (carbohydrate conversion)
- Polyols for poly-urethanes (direct application)
- Butanol (fermentation)
- Bleach activators (derivatization)
- Phosphate recycling/fertilizers (Ash utilization)
- Fodder (protein fraction)
- .....

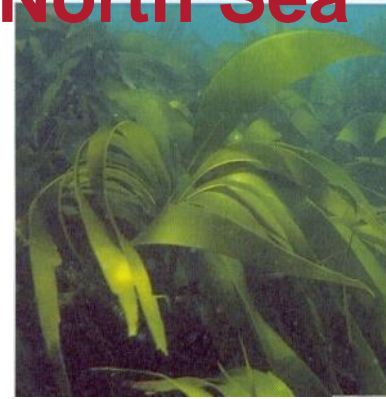
# Seaweed species native to the North Sea



Laminaria saccharina



Laminaria digitata



Laminaria hyperborea  
(Perez)



Ulva sp.

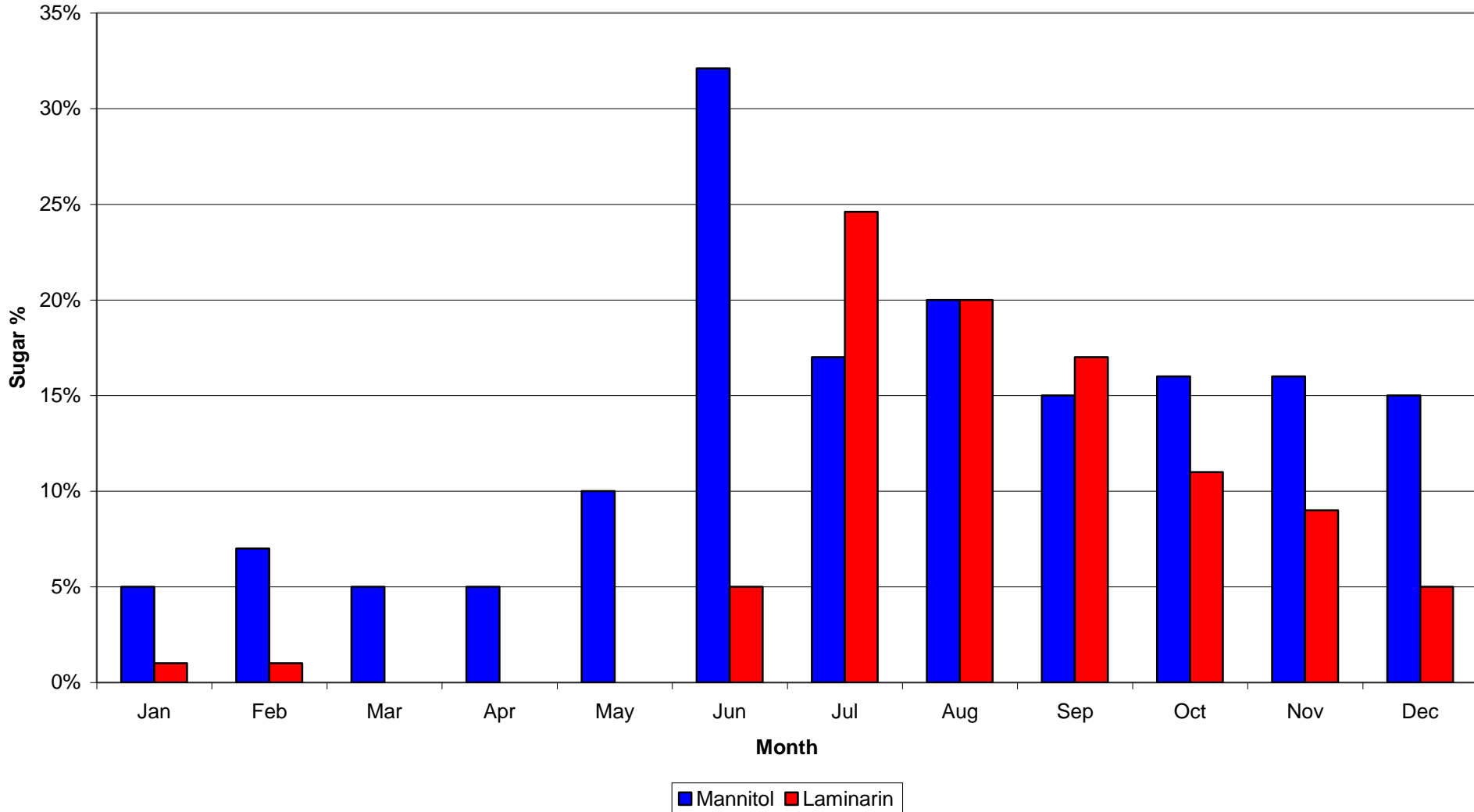


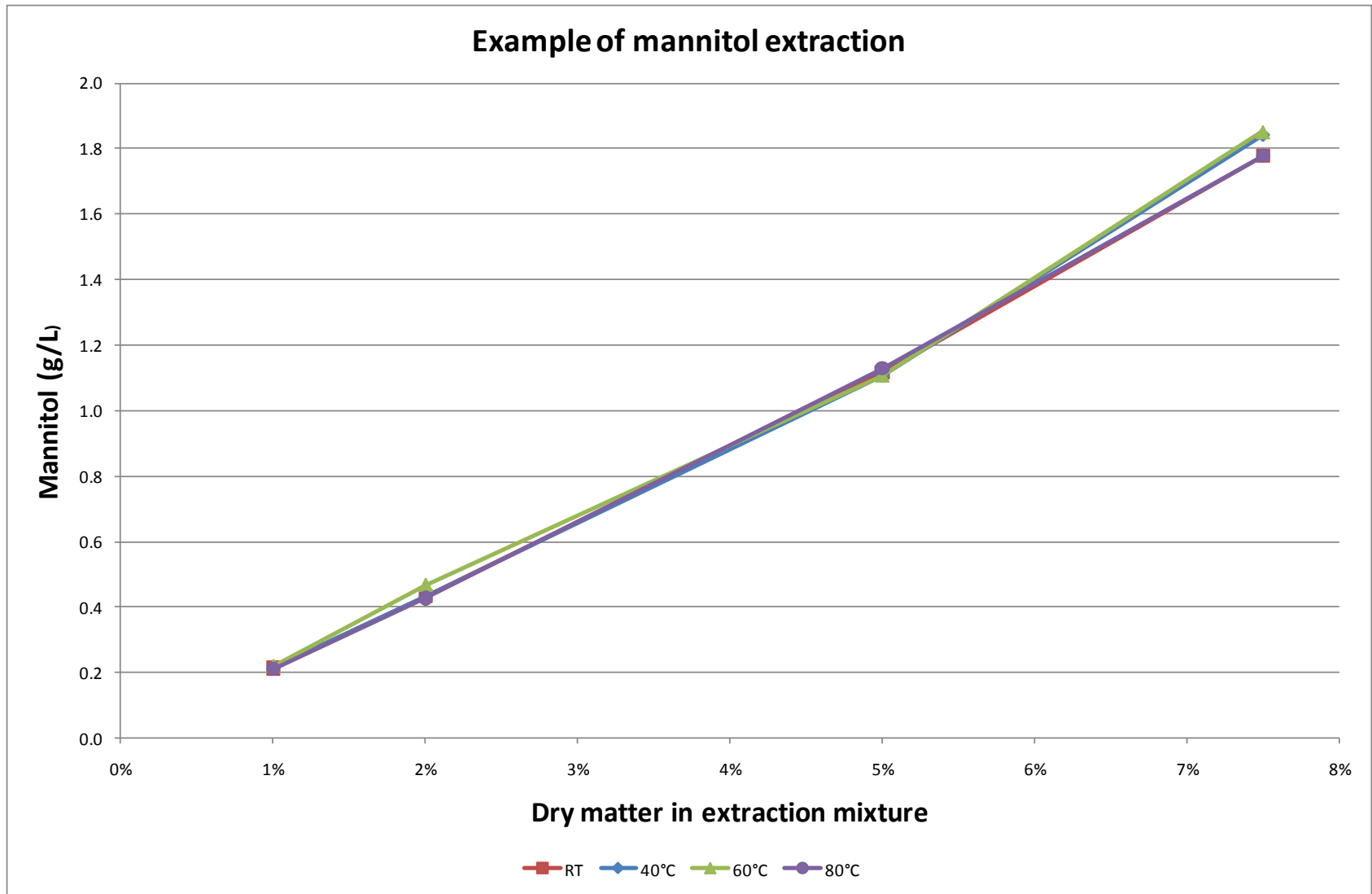
Alaria esculenta (Irish  
Seaweed Centre)



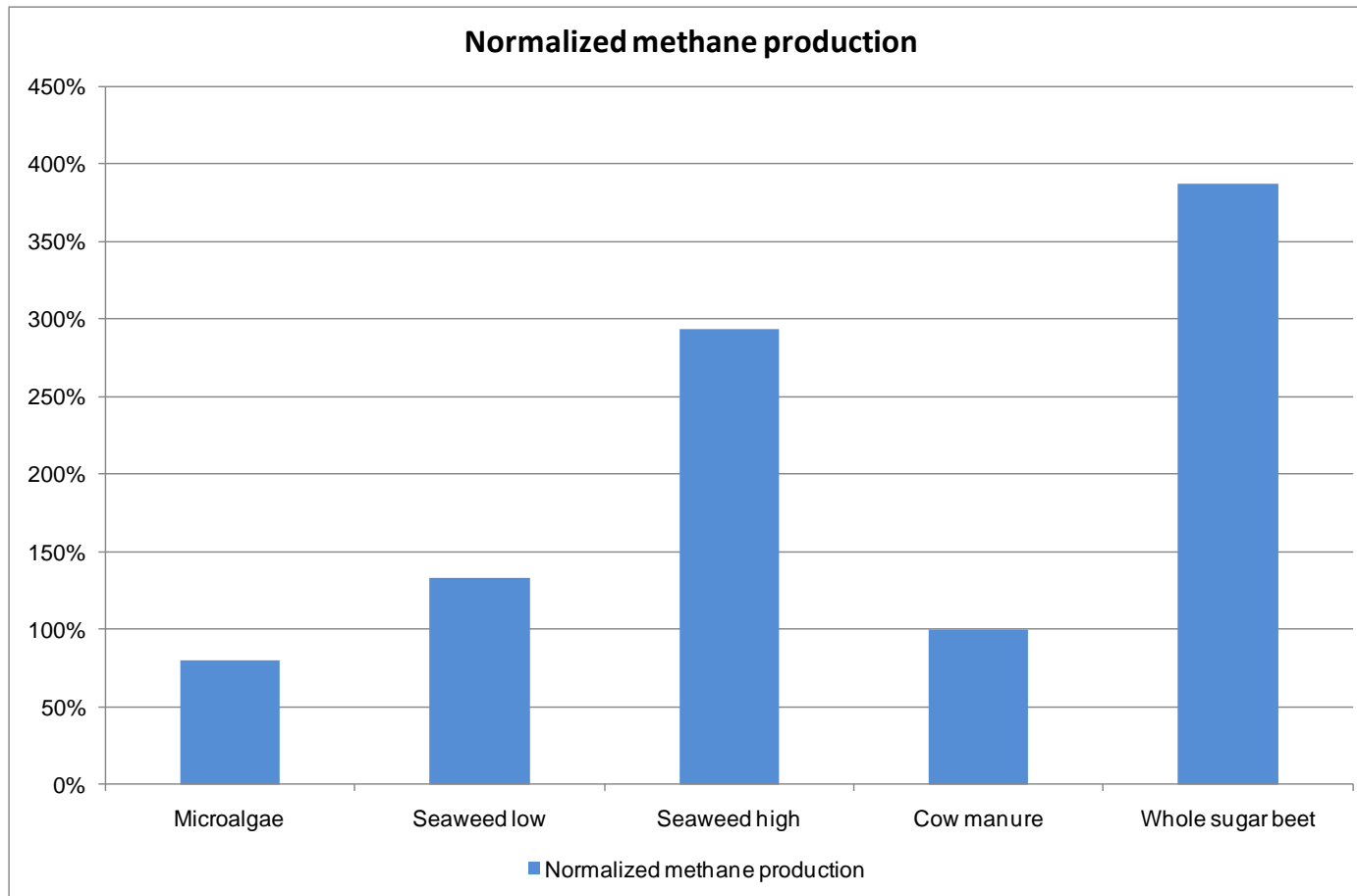
Palmaria palmata  
(AWI)

### Laminaria Digitata





# Digestion results



## Fermentation results

- ABE fermentation
  - C5 synthetic sugar mix (*Palmaria*)
  - C6 synthetic sugar mix (Kelps)
- Sequential metabolism of carbohydrates
- Hydrosylates ferment slower

## Summary

- Large potential for using seaweed as sustainable biomass supply
- Seaweed is an excellent source of (specialty) carbohydrates
- Seaweeds digest well (to methane)
- Seaweed carbohydrates can be fermented to chemicals and fuels
- Selective extraction of carbohydrate molecules appears technically feasible

## Question?

### Further information

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