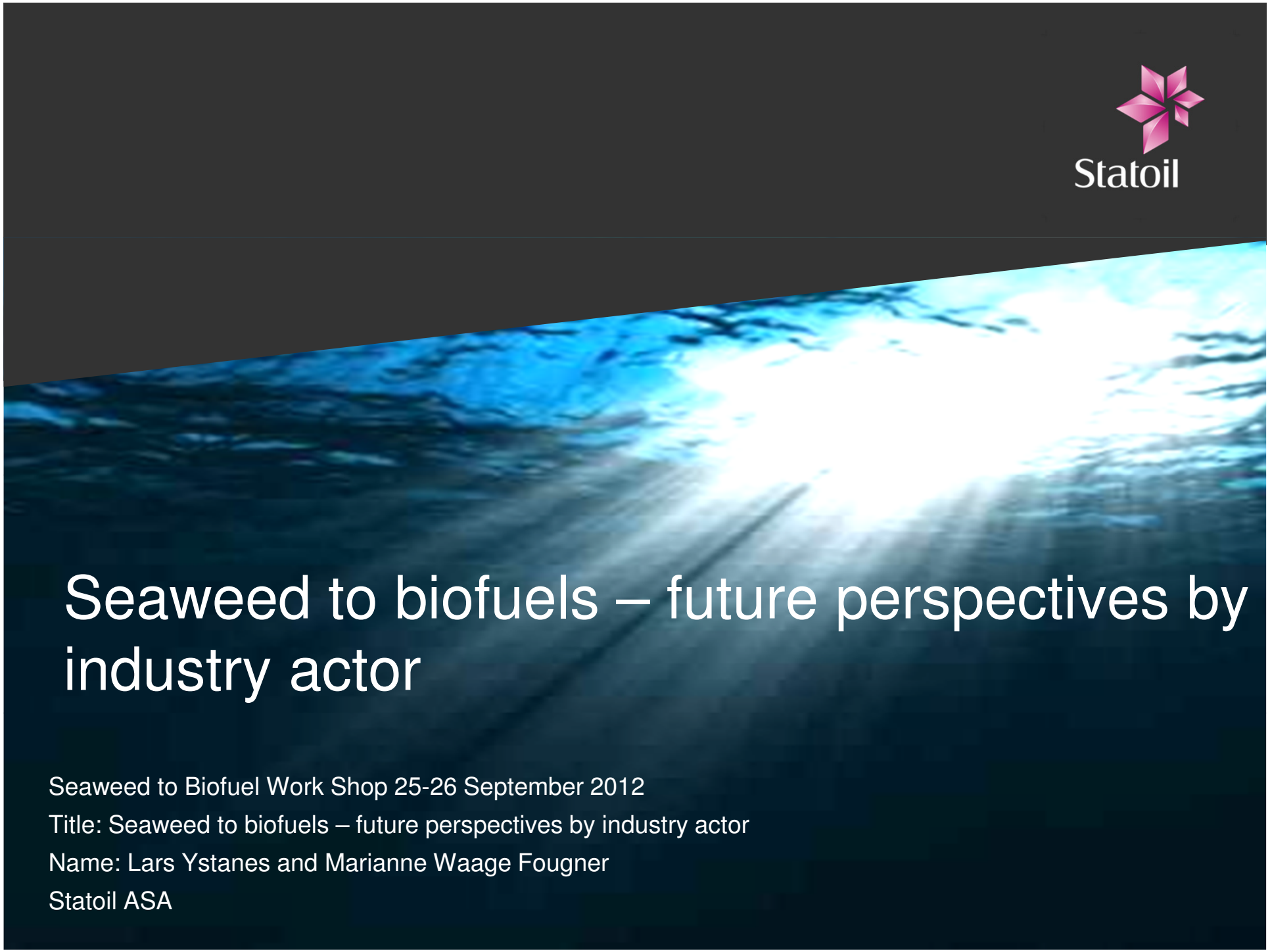


Seaweed to biofuels – future perspectives by industry actor

Seaweed to Biofuel Work Shop 25-26 September 2012

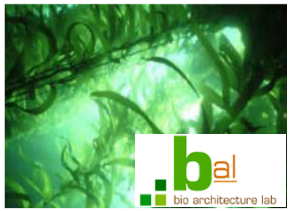
Title: Seaweed to biofuels – future perspectives by industry actor

Name: Lars Ystanes and Marianne Waage Fougner

Statoil ASA

Statoil's R&D activities
Biofuel and biotechnology

- Biofuel
  - Seaweed to ethanol project
  - Participation in demonstration projects
  - R&D activities on butanol and etanol fermentation
  - Evaluation of biorefinery concepts



- Biotechnology
  - Bio prospecting
  - Designer organisms for Enhanced Oil Recovery

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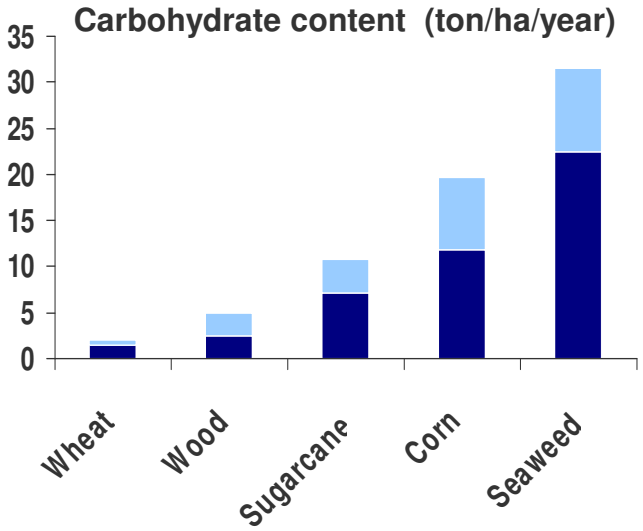
Seaweed – a promising feedstock for biofuels



Seaweed as feedstock:

- High sugar content and productivity
- Excellent growth condition in Norway
- Mitigate eutrophication
- Restore vegetation of seaweed
- **But – difficult to convert all the complex sugars in seaweed to ethanol**

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Good conditions for kelp farming in Norway

- Macro algae have high productivity
- Long coast with cold nutrient sea water provide optimal condition for large scale farming of macroalgae

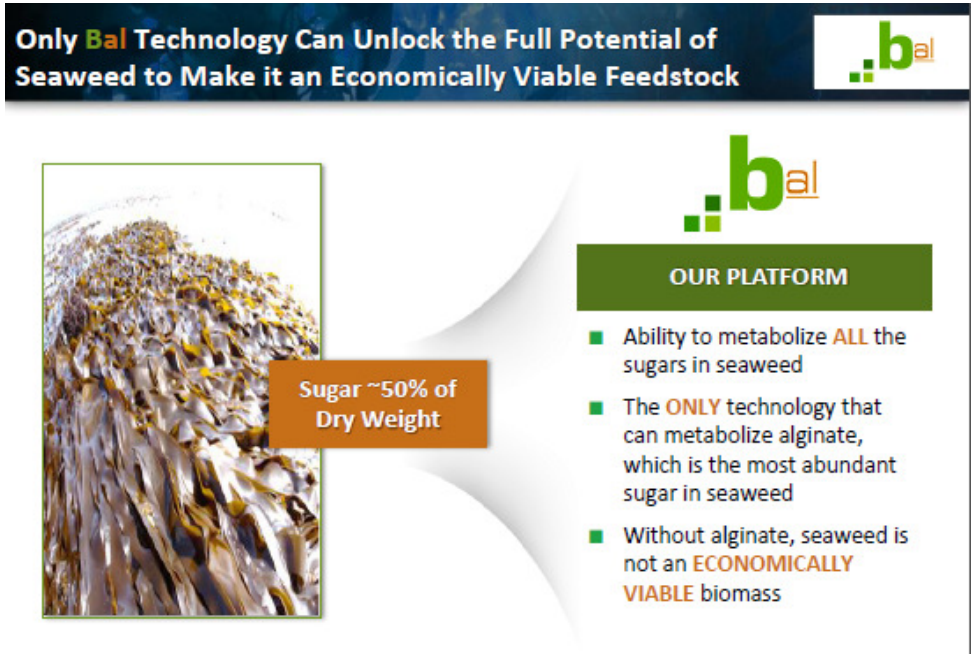
From Statoil/SINTEF's growth

Tests 2009-2010

- Energy (biofuel)
- Marine proteins
- Fertilizer
- Alginate
- Integrated aquaculture
- Carbon storage

Statoil and BAL* has entered a Collaboration Agreement for development of a commercial concept for conversion of seaweed to ethanol

- Development of microbes for efficient fermentation of all sugar types in seaweed (BAL).
- Design basis for a conversion plant (BAL).
- A seaweed cultivation and harvesting concept (Statoil in collaboration with Seaweed Energy Solution)



* - Bio Architecture Lab (BAL)* is company developing microorganisms for fermentation of seaweed. Statoil's venture capital company, Statoil has acquired 20% equity in BAL.

Statoil

Statoil and SES has entered a Collaboration Agreement for development of a commercial concept for cultivation of seaweed

SES is developing technology for:
- large scale seaweed cultivation
- harvesting concepts

Statoil will contribute to:
- development of SES technology
- technical support
- financial support

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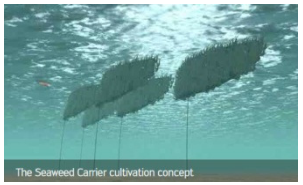
Statoil's macroalge to ethanol project, Partners in the pilot

Seaweed Energy Solution AS

Concept for cultivation and harvesting



Bio Architecture Lab
Microbe and production technology

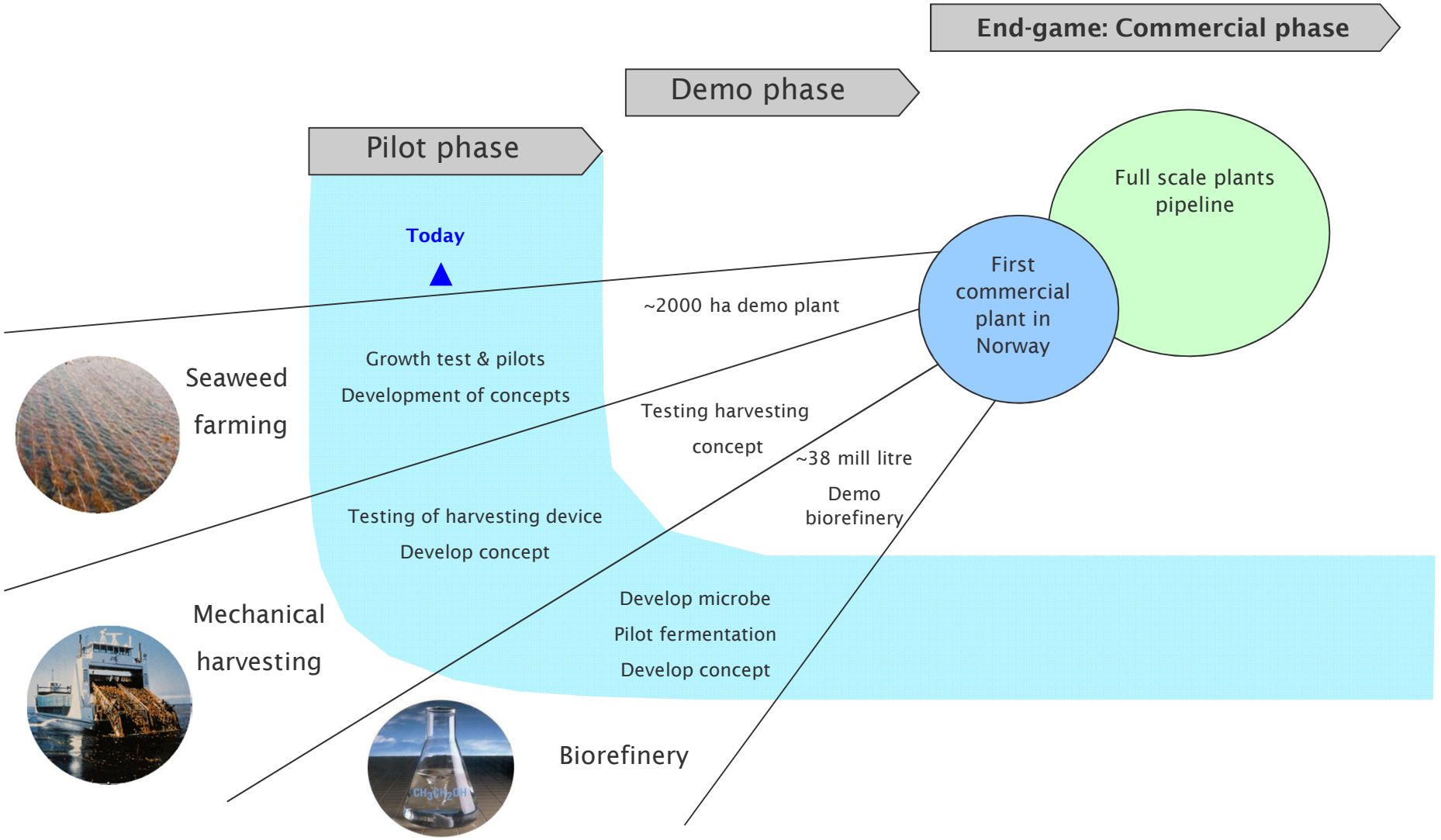
Proteins

Seedlings production → Cultivation → Harvesting → **Bioraffinery Convert weed to ethanol** → Ethanol market

Fertilizer and Soil improvement

Statoil

Seaweed to ethanol
Stepwise approach towards commercialisation



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Challenges

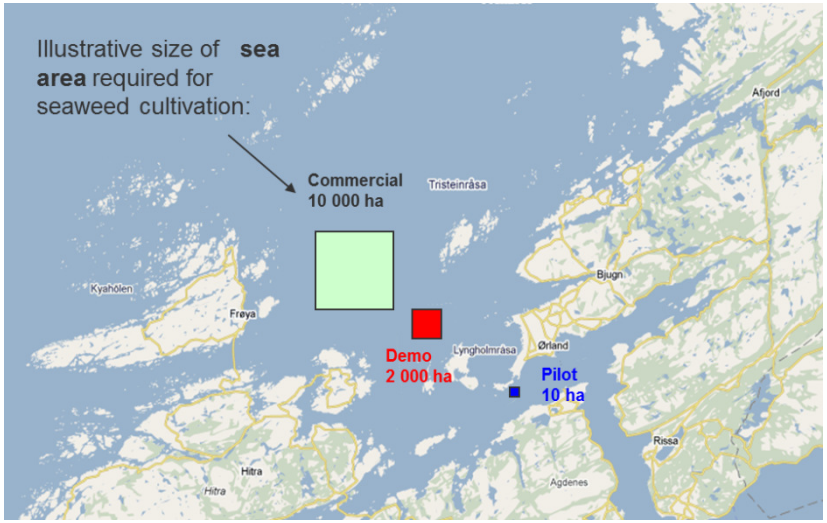
- Farming and harvesting
  - Cost efficient mechanical solution
  - Large scale marine mono culture and avialable nutrients
  - Develop well suited kelp strains with high robustness, high crop potential and with sufficient sugar content (strain selection)

- Acces to area
  - Site selection
  - Area planning / Public regulations (aquaculture act)

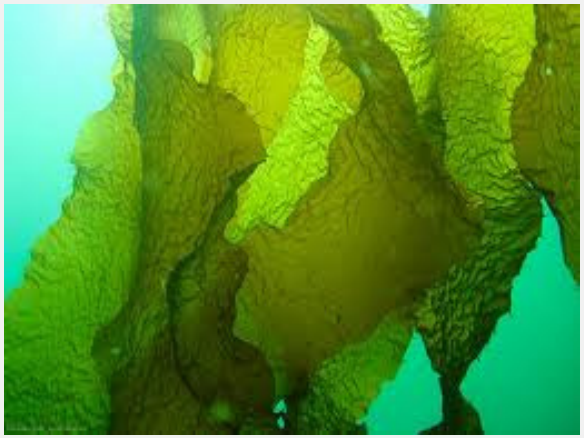
- Research & development
  - Financial support (e.g. development of demo plant)

Upscaled seaweed-to-ethanol requires access to marine areas close to onshore infrastructure

Sea area required for annual 200.000 tonnes of ethanol (2% of EU's ethanol marked)



There's never been a better time for good ideas



Presentation title

Presenters name

Presenters title

E-mail address ……@statoil.com

Tel: +4700000000