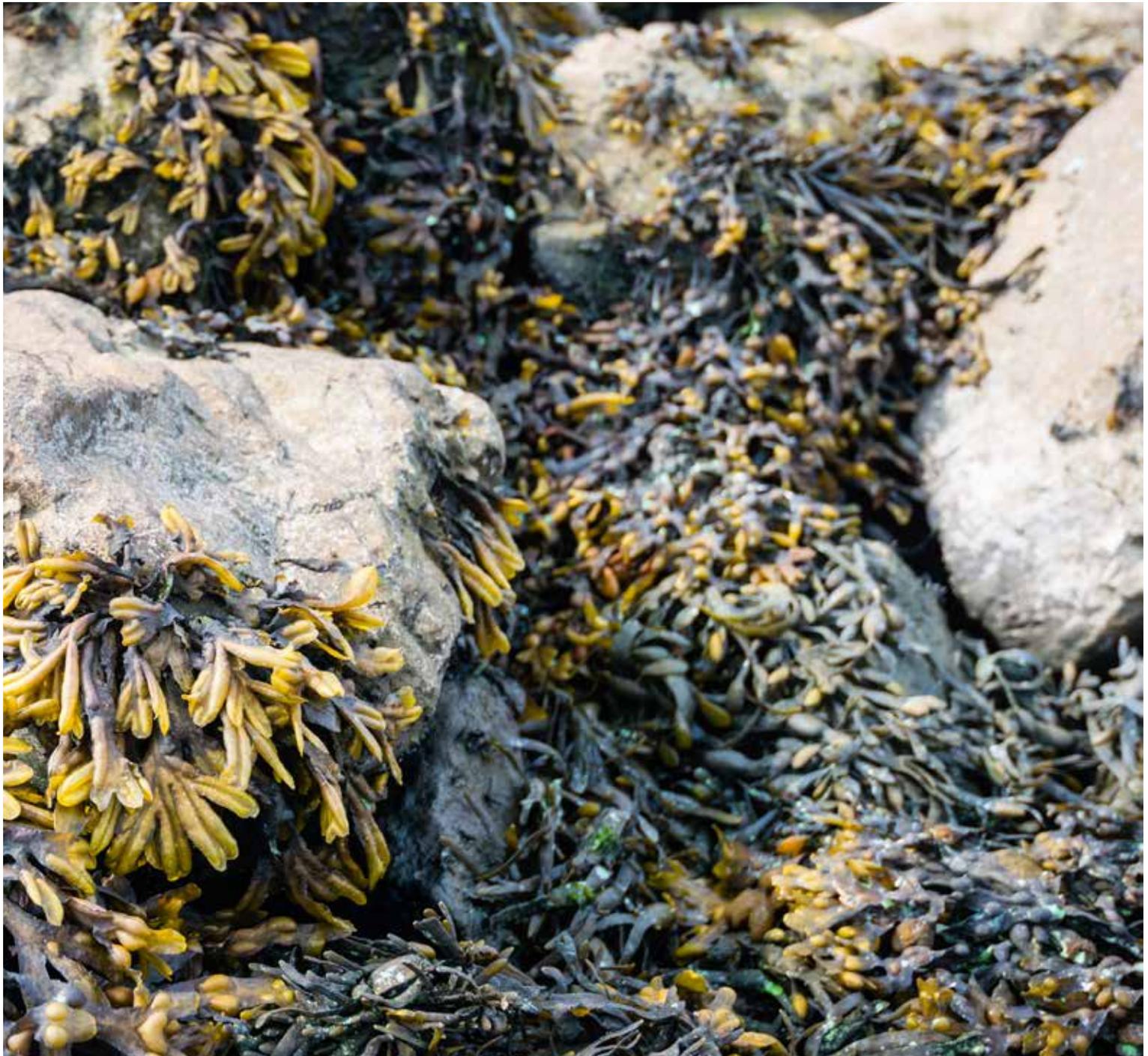


Nordic Algae Network



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Table of contents

Project participants	6
Project participants	7
Table of contents.....	8
Preface & acknowledgements.....	9
Executive summary	10
Main Objectives	10
Discussion of the main objectives.....	10
Methods and implementation.....	11
Concrete results and conclusions	11
Recommendations for further work.....	12
1 Reporting the activities	14
Kick-off meeting	14
Workshop in Iceland.....	14
Workshop in Denmark.....	16
Workshop in Norway	18
Workshop in Sweden	19
Final conference in Denmark.....	21
2 Dissemination.....	23
Newsletters	23
Information on websites.....	23
Additional dissemination. Newspapers and TV.....	24
Table of abstract.....	26

Preface

Main goals: The project aim is to help the participants to a leading position in the field of utilizing algae for energy purposes and for commercial exploitation of high value compounds from algae. An additional aim is to increase the synergy and facilitating collaboration between the participants involved in the project and thereby increase their ability to compete in this new field.

News and innovative value: Algae are the largest un-exploited biomass resource, which possess vast potential as resource for an array of different applications including sustainable energy carriers, chemicals, pharmaceuticals and ingredients for the food and feed industry. Industrial scale utilization of marine algae requires intensive development of growth, harvest and conditioning systems that secure reliable delivery of large amount of biomass at the right time, quality and condition. A long innovative process is necessary to be able to scale up the algae production to meet the increasing demand for biomass for many different purposes.

The importance of the project: This project is a network project with focus on a majority of industrial partners in dialogue with research institutions. The network will increase the ability of the involved industries to evaluate their business opportunities for production based on algae raw materials, and the network will strengthen the cooperation and sparring between the Nordic partners. In addition the newsletters and the website will give a large network for algae activities in the North Atlantic area including England, Scotland, Ireland, Faroe Island, Greenland and the east coast of Canada.

Executive summary

Main Objectives

The main activities are: four workshops open to all stakeholders in the algae field, one conference, a website and newsletters. The outcome is expected to be:

- Increased know-how about algae cultivation and utilization among the participants
- Increased contact between the participants, basis for cooperation and business activities
- New ideas for production based on algae as raw material
- New ideas for demonstration projects to support industrial innovation
- An Algae-website, which is maintained after the project period.
- An innovative platform for future algae cooperation in the Nordic marine sector.

Discussion of the main objectives

At this very early stage of commercial exploration of algae this action has been very fruitful. The idea of putting stakeholders in the algae-field together was right, because there has not been an overview among the partners of what is ongoing, with both macro- and microalgae. The workshops have been a good tool to open discussions between industrial partners and academia, and the industrial partners have been quite open although there were competitors among in the workshops. Furthermore, the algae conference in Denmark, which was held in cooperation between Nordic Algae Network and AlgaeCenter Denmark in 2012 and 2013, is now an internationally established event in the algae community and is held for the 4th time in October 2014. Project partners from Nordic Algae Network has participated and presented results at the last two conferences.

A website and email newsletters is a prerequisite today in order to meet our audience. This has worked well and the project has received a lot response on newsletters and web-activities. The website www.algecenterdanmark.dk has been used as a platform for project partners as well as other stakeholder in the algae field to find information. The website contains publications, project descriptions, links etc. and will remain operational and regularly distribute news from the algae community.

Methods and implementation

The methods used in the project in the project activities are:

Workshops with short presentations, group discussions and plenum discussion

Conference with international participation and international "Call for abstracts"

Poster sessions at workshops and conference

Newsletters distributed by email

Information on two websites: www.algecenter.dk and www.nordicinnovation.org

Press release to newspapers and TV

Concrete results and conclusions

Overview. 6 statements:

Many algae stakeholders in the four countries have been brought together

There are many Nordic activities in macro- and microalgae industries

The technological level for producing and using algae is in an early stage

New projects have started between partners in the network

There are several small-scale industries (SME's) in the algae field

The Nordic brand is strong, and useful for international promotion

Results and conclusions in detail:

The algae network will be maintained through AlgeCenter Danmarks activities, among others through the annual invitation to the Nordic Seaweed conference. It has been very important that this project was an inter-Nordic project, because the partners had only little knowledge about what happened in the other Nordic countries in the algae field. The project has changed this situation. In addition cooperation with industries in Faroe Islands has started because of the project. Some new activities as a result of the project can be mentioned. This includes Horizon 2020 applications and the MacroBio-tech project funded by NORA in Torshavn:

- Matis in Iceland is cooperating with Danish Technological Institute
- Danish Technological Institute is cooperating with Syntesa, Faroe Islands
- DUE Miljø, Norway has 2 new partners and 1 new project
- Norges Vel has 5-10 new partners and 1 new project
- Havets Hus, Denmark has 10 new contacts for use in upcoming projects.
- The Swedish SeaFarm project has invited Danish Technological Institute in the Advisory Board of the project.
- Danish SME's have been more active involved in R&D algae applications.

The overall conclusion of the project is that the focus on industrial involvement has been a successful approach, because many companies are new in the algae field and many are SME's with limited capacity to look for other industrial partners and to look for support from the academia in their R&D efforts.

Several project partners have indicated they have had great results from the overall participation in Nordic Algae Network. Anne Mugaas from Norges Vel wrote the following after the project had official stopped:

“Norges Vel has benefited greatly from participating in the kick-off meeting in Oslo in January 2011 as well as the workshops in Iceland, Denmark and Norway. We were invited to give a speech in May 2011 in Iceland about the status in Norway on research and industrial utilization of macro- and micro algae. Our participation has resulted in good contact with several research groups, an overview of some of the more commercial stakeholders and understand the development of the algae sector in the Nordic countries. Likewise, we have established contact to other European participants. The network has contributed to our knowledge of the activities in and strengths of the different countries concerning the development of macro algae growing, harvesting and processing to specific products (food, cosmetics, energy, feed, and fertilizer), markets and development etc. We have also been able to impart knowledge referred to smaller Norwegian entrepreneurs.

When it comes to the final conference, it was very rewarding for several reasons. The conference gave a very well updated overview of what goes on in the area in terms of both research and development and commercial activities. The program provided an updated insight into different utilization characteristics of both macro- and micro-algae, and the mix between presentations, poster session, breaks and dinner, gave many opportunities to make contacts. At present, we use contacts achieved to further develop a number of initiatives with Nordic entrepreneurs in growing, processing and marketing of algae.” Anne Mugaas, Norges Vel

Recommendations for further work

The project partners and the other delegates at the workshops have worked out SWOT analyses (Strength-Weakness-Opportunities-Threats) for the algae activities in the four countries. The set-up for the SWOT discussions was the same at all four workshops. The delegates were divided in 4-5 groups, one English speaking, the other groups used their national language. This similar approach makes it possible to extract 4 trends from the SWOT analysis for the algae future in the Nordic countries.

- There is an entrepreneurship and innovative spirit among industries and academia in the countries which is a very important tool for development of this new area.
- The technology for large-scale production of algae is not developed yet. There are large industrial companies in the food and feed processing sector which are ready to use algae as raw material if a large and stable supply is possible.
- The consumers market both in the Nordic countries and Europe are un-mature and not ready to use algae in the daily food. The organic food trend and the Nordic Brand can maybe help the algae products to a faster acceptance from the consumers. Among the industries producing algae products there are only limited market knowledge.
- No clear laws and regulations for production of algae offshore exists. There is a need for both spatial and environmental regulations in order to cope with problems from fishery, maritime traffic, tourists, aquaculture, windmills, wild life protecting areas and environmental impacts.

At the Nordic Seaweed conference in Denmark in 2013, the delegates answered a questionnaire. The recommendations from the 4 SWOT analysis and the questionnaire concerning the future for algae activities in the four Nordic countries can be summed up as follows:

- Extracting bio-active molecules from algae
- Enzymatic treatment of algae for optimized extraction
- Marketing and sales of algae products. Un-mature market in Europe
- To replace import of soya protein with local algae protein
- To understand seasonal variation in the algae compounds
- To support industries with new raw materials
- Developing technologies for anaerobic digestion of algal biomass
- Develop technologies for large-scale production of algae
- Need for environmental legislation for production of algae
- Support new and existing SME's in micro- and macro algae production
- Develop industrial methods for producing biofuels of algae
- Focus on algae in organic food and feed production
- Focus on sustainable niche production in fish farms (IMTA)
- Branding algae as Nordic Food
- Lobby activities to give politicians information about algae
- Microalgae can be an important omega-3 FA and functional food source
- High level of entrepreneurship and innovative spirit in the Nordic countries
- Important to go on with the annual seaweed conference

1 Reporting the activities

Kick-off meeting

The kick-off meeting took place in Oslo on 26. January 2012. Ten partners from the project took part, from Denmark, Norway and Iceland. The project was briefly introduced by Danish Technological Institute, and a broader discussion on how the four workshops should be arranged took place. According to the main target of the project, this is a network focused on industry participation. In the project, researchers from Universities and other research institutions shall not be excluded from participation in the workshops, but we shall keep in mind that the network shall help the industry to perform better in the algae field

Workshop in Iceland

The first workshop took place in Iceland on 15. May 2012 at the Blue Lagoon Conference facilities near Reykjavik with 60 delegates. The workshop was divided into two parts, presentations and discussion groups. The presentations were from Iceland, Denmark, Norway and Ireland and they addressed various algae related topics to the mentioned countries. The focus in the discussion groups was a SWOT-analysis of the algae situation in Iceland. SWOT is STRENGTH, WEAKNESS, OPPORTUNITIES and THREATS. The groups analyzed the threats and weaknesses in Iceland connected to marine algae and potential solutions. The groups also addressed the strengths and future opportunities in Iceland connected to marine algae.

In summary, the workshop pointed out some of the strengths and future opportunities that Iceland has to offer. They include

- Knowledge and experience in processing and selling seafood
- Short communication channels
- Purity of the sea around Iceland
- Hot geothermal resource
- Unique Icelandic ecosystem and algae species
- Positive environmental image of the brand "Iceland"
- Very large wild resource of macro algae
- Human capacity is large
- Icelanders mindset is skilled in entrepreneurship
- There is already a forum where SMEs can discuss with the academic sector in Iceland
- Strong local traditions is a strength
- Possible bio diesel for transport
- Keeping a future bio refinery in Iceland and not export the raw material

The workshop pointed towards some limitations and weaknesses in establishing an algae industry in Iceland, such as:

- Limited expertise
- Insufficient funding
- limited market knowledge
- SME's are too small to afford trials and tests
- Europe is not the best market for export
- Consumers not ready for algae as food
- Need for regulation of certain species of algae

Solutions to address these issues are needed. Iceland is poised to become a leading country in the utilization and value addition of both micro and macro algae in the future, and the workshop was a significant contributor to see that goal realized.

The agenda and the presentations can be found on:

<http://www.matis.is/um-matis/frettir/nr/3441>.



Figure 1. SWOT discussion at Blue Lagoon on the Icelandic Workshop on 15.May 2012

After the workshop, there was visit to the micro algae production facility for the company Blue Lagoon International who produce the Blue Lagoon cosmetic products from two types of micro algae in the hot wastewater from the hydrothermal power plant nearby.



Figure 2. Ása Brynjólfsson from Blue Lagoon International explains about the micro algae production which are used as ingredient in cosmetics products

Workshop in Denmark

The second workshop took place in Denmark on 20. September 2012 as part of a 2-day conference in Grenå. The title of the Grenå conference was: Macro Algae from research to industry – in a Nordic perspective and was attended by 90 delegates. The Nordic Algae Network workshop on 20. September was divided into two parts, presentations and discussion groups. The presentations were from Iceland, Denmark, Norway and Sweden and they addressed various algae related topics to the mentioned countries. There was short presentation from Danish industry delegates in the algae fields. The focus in the discussion groups were - like in Iceland - a SWOT-analysis of the algae situation in the Danish industry. The groups addressed the strengths and future opportunities and in summary, they pointed out that:

- Denmark is generally viewed as an adaptable and innovative country
- There is a good networking activity
- There is experience in production off-shore on lines/ropes
- Some industries are interested in buying large amount for feed production
- Some industries are interested in buying large amounts for high value product production
- Internationally known brand of "New Nordic Cuisine" and generally strong Nordic brand
- Short distances on shore/off shore
- 7.000 kilometer of coastal line is an advantage
- Increasing research in cooperation with industries
- General national focus on sustainability also from politicians
- Cultivation of algae take up nitrogen
- Algae can be used in organic food and feed
- It may be possible to use phosphorus from algae as soil fertilizer

The groups analyzed the threats and weaknesses and in summary, they pointed out that:

- Danish wages are high,
- Need clarifications on health issues related to algae intake
- Difficulties for SME's to finance development,
- Low interest from consumers side
- A stable large-scale algae supply to the industry round the year is still missing.
- Poor economy for bioenergy and bulk products
- No legal framework for off-shore production
- Environmental impact of off-shore cultivation systems are still unknown
- Strong competition from Asian import
- Needs technological development
- Visual "*contamination*" of beaches
- No commercial storage technology yet available
- Technology for removal of salts not yet developed

The agenda and presentations is available on:

<http://www.algecenterdanmark.dk/conferences/danish-macro-algae-conference-2012.aspx>



Figure 3. From the Poster Exhibition at the Grenå Conference 19. - 20. September 2012

Workshop in Norway

The third workshop took place at Norwegian University of Life Sciences in Ås on 15. to 16. November 2012. The workshop was made in cooperation with the Interreg project Blue Bio <http://www.bluebio.org/home/8-about-blue-bio.html> managed by Chalmers University of Technology with one day for each project. There were 78 delegates. The presentations were from Iceland, Denmark, Norway and Sweden. There were discussion groups with SWOT analysis of the Norwegian industries and their commitment in the algae field. The groups addressed the strengths and future opportunities and in summary, they pointed out that:

- Norwegian regulation for wild stock harvest is good
- Good inshore locations can be used for cultivation
- Cultivation will prevent eutrophication of sea areas
- Cultivation is a new industry that will create new jobs
- The Norwegian oil industry can support cultivation with their off-shore experience
- Long coastline
- Established seaweed industry
- The White Paper on Agriculture: "*Landbruksmeldingen, - Landbruks- og matpolitikken, Velkommen til bords – 2011*" state that Norway need to increase the production of food
- There is a potential for IMTA (Integrated Multi Trophic Aquaculture)
- Cultivation of algae may act as bioremediation
- Clear waters and a known brand of "clearness and purity"
- Microalgae is a promising source of fatty acids
- Cheap electricity from hydro power
- Omega-3 fatty acids from algae can be used for fish feed

The groups analyzed the threats and weaknesses and in summary, they pointed out that:

- The annual harvest of wild stock is 150.000 tons, concern about increased harvest
- Technology for cultivation need to be developed
- Regulation and management for cultivation needs to be developed
- Cultivation in exposed areas is challenging
- Generally people tend to use conservative approach
- Competition with the salmon industry for cultivation sites
- Limited cultivation sites
- Regulations and management of concessions need to be developed
- R&D groups tend to be isolated from mainland Europe
- No commercial micro algae production takes place in Norway
- Research and industry must work more closely together
- The large petro industry may lower motivation for exploring new opportunities

The presentations are at www.nordicinnovation.org/nordicalgae



Figure 4. Leiv Mortensen from UMB was leader of one of the SWOT discussion groups in Ås

Workshop in Sweden

The fourth workshop took place in Göteborg at Chalmers University of Technology on 28. February 2013. There were 57 delegates. The presentations were from Iceland, Denmark, Norway and Sweden. There were discussion groups with SWOT analysis of the Swedish industries and their commitment in the algae field. The groups addressed the strengths and future opportunities and in summary, they pointed out that:

- The chemical industries are looking for new types of raw materials
- Sweden has a very solid technical sector with a long tradition
- Sweden has a good ability of innovations
- Sweden has a strong basic research on algae in academia at international level
- There is a trend to eat organic food, and like local food products
- Good in trans-disciplinary work
- Pronounced environmental thinking
- Long coastline
- Politicians appear willing to support the algae field
- Strong environmental regulations
- Good access to different types of water (fresh, brackish, salt)
- Good international Scandinavian brand
- Algae can help clean run-off water from land

The groups analyzed the threats and weaknesses and in summary, they pointed out that:

- Only little awareness in Sweden about possibilities in algae production
- Difficult to get permissions. Strict environmental and food regulations
- Decision-making can be slow in Sweden. Afraid of making mistakes
- There is a gap between academia and companies dealing with algae
- Swedish companies dealing with algae are mainly small and new companies
- The Swedish initiatives are scattered in many small units/companies, by which knowledge and experiences are not shared
- We are far behind other countries regarding cultivation and use of macro algae. Most aspects of cultivation and use of macro algae in Sweden need to be developed (until now the main focus has been on microalgae)
- Competition from Asia with algae products
- The Swedish companies dealing with algae are mainly new and small companies. This makes them vulnerable
- Very difficult to get competent external risk funding to support up-scaling projects
- Shortages in the transition of ideas into commercialization, i.e. a gap between scientists and entrepreneurs
- Up until now, there has been a lack of networks within the algae field

See the presentations on: <http://www.nordicinnovation.org/nordicalgae> and <http://www.chalmers.se/chem/SV/annesomraden/livsmedelsvetenskap/aktuellt>



Figure 5. The Swedish workshop 28. February 2013. Ola Dahlman, Tångbrödspecialisten and Eva Albers, Chalmers University of Technology discussing with the audience

Final conference in Denmark

The final conference took place in Denmark on 9.-10. October 2013 in Grenaa and was attended by 85 delegates. Scientists and businesspeople from 10 different countries participated in the final conference. It was two lively days with presentations and exchange of ideas and business cards. Each participant had an interest in algae and its manifold compounds but each with an individual approach. Both algae farmers, researchers, cosmetics-makers, feed-producers and many more were present.



Figure 6. Visit to the test facility at the final conference in Grenå 9.-10. October 2013

97% of the delegates indicated in an anonymous evaluation that they were satisfied with the conference and 90% that they participated in the conference to strengthen their international network and to increase their knowledge on algae.

Some of the comments from the evaluation were:

- There were many interesting presentations, and many different subjects
- It was a good mix of presentations from applied research and industry. It was obvious that there's been a big leap in development within the macro algae utilization and culturing since last year, which was very inspiring
- It was very interesting and well-focused
- Two educational days, a nice mix of academic posts and pleasant conversations
- Good overview of algae activity in Nordic countries. A lot of new projects and interesting results / Nice to get the opportunity to meet the persons behind the projects
- Very nice conference. Broad topics and good presentations
- It was good to see such a broad array of presentations

See the presentations:

<http://www.algecenterdanmark.dk/conferences/danish-macro-algae-conference-2013.aspx>

No	Partner	kick-off Oslo	Island WS	DK WS	Norway WS	Swe WS	Conf DK	Sum
1	DTI, Danmark	1	1	1	1	1	1	6
2	Norwegian Uni., Norge	1		1	1	1	1	5
3	Chalmers Uni., Sverige		1	1	1	1	1	5
4	Matis, Island	1	1	1	1	1	1	6
5	Havets Hus, Danmark		1	1			1	3
6	Tångbrödsspecialisten, Sverige					1		1
7	Everts Sjöbod, Sverige							0
8	Marin biogas, Sverige					1		1
9	N-Research, Sverige					1		1
10	Algetech Inudstrier, Norge	1						1
11	DUE Miljø, Norge	1				1	1	3
12	Biopharma, Norge	1			1			2
13	Marinox, Island	1	1	1			1	4
14	Blue Lagoon International, Island		1				1	2
15	Green in Blue							0
16	Islensk Blåskel, Island		1				1	2
17	Nyland Biotech, Island		1					1
18	Orbicon, Danmark			1			1	2
19	MareLife Partner, Norge	1			1	1	1	4
20	Norges Vel., Norge	1	1	1	1		1	5
21	Danish Shellfish Center, Danmark			1			1	2
22	AstaNovo, Norge	1						1
		10	9	9	7	9	13	57
TOTAL NUMBER OF DELEGATES		10	60	90	78	57	85	380

Figure 7. Participation of the project partners in the national workshops. 1 indicates that one or more stakeholder from the company participated in the workshop. The total number of participants is indicated on the bottom row.

2 Dissemination

Newsletters

The first activity was to make email lists for communication with stakeholders within the algae field in North Europe and the North Atlantic area. The partners in the project were asked for addresses, and in February 2014 the list consists of 769 email addresses. The addresses are divided in four groups: Danish 370, Norwegian 152, Swedish 75, Iceland 82, others 90. Others are Faroe Islands, Greenland, Canada and North Europe.

Newsletter no.1 was distributed in April 2012 to all email addresses informing about the newly started network and with invitation to the Icelandic workshop.

Newsletter no.2 was distributed in August 2012 to all email addresses informing about the Algae conference in Bodø in May, the 20th European Biomass Conference in Milano in June and with invitation to the Danish workshop on 20. September.

Newsletter no. 3 was distributed in November 2012 with invitation to the workshop in Ås, and info about the Danish workshop in September.

Newsletter no. 4 was distributed primo February 2013 with invitation to the Swedish workshop on 28. February, with information about the Norwegian workshop, the Blue Bio workshop and the WAB (Wetland, Algae, Biogas) conference in Trelleborg 28. November 2012.

Newsletter no. 5 was distributed in February 2014 and summed up the overall results from the project and thanked all the participants for their work in the project. Newsletter no. 6 will be distributed in 2014 when the final report is printed.

Information on websites

<http://www.algecenterdenmark.dk/> and <http://www.nordicinnovation.org/nordicalgae> has been used to communicate newsletters, news about the project and general news on the algae field. The www.algecenterdenmark.dk website has been regularly updated and will be maintained after the project. This means that interested stakeholders will be able to find information about algae and spin-off projects from the Nordic Algae Network in the future.

Additional dissemination. Newspapers and TV

http://www.tv2oj.dk/arkiv/2012/9/19?video_id=30558&autoplay=1 Video from TV2 Østjylland about the Conference in Grenaa 19.-20. September 2012.

http://www.tv2oj.dk/arkiv/2013/10/9?video_id=40689&autoplay=1 Video from TV2 Østjylland about the final conference in Grenaa 9.-10. October 2013

<http://www.algecenterdanmark.dk/conferences/conference-inspiration-video.aspx>
Video made about the final conference in Grenaa, Denmark



Figure 8. From the test facility at AlgeCenter Denmark which is used in marine dissemination activities for school children and students. The picture is showing Danish schoolchildren at AlgeCenter Denmark on Researchers Day 30. April.2013



Figure 9. Michael Bo Rasmussen from Århus University explaining about algae in Danish TV during the final conference in Grenaa in October 2013

Table of abstract

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Organisation(s): Danish Technological Institute	
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<p>Abstract: Main goals: The project aim is to help the participants to a leading position in the field of utilizing algae for energy purposes and for commercial exploitation of high value compounds from algae. An additional aim is to increase the synergy and facilitating collaboration between the participants involved in the project and thereby increase their ability to compete in this new field .</p> <p>News and innovative value: Algae are the largest un-exploited biomass resource, which possess vast potential as resource for an array of different applications including sustainable energy carriers, chemicals, pharmaceuticals and ingredients for the food and feed industry. Industrial scale utilization of marine algae requires intensive development of growth, harvest and conditioning systems that secure reliable delivery of large amount of biomass at the right time, quality and condition. A long innovative process is necessary to be able to scale up the algae production to meet the increasing demand for biomass for many different purposes.</p> <p>The importance of the project: This project is a network project with focus on a majority of industrial partners in dialogue with research institutions. The network will increase the ability of the involved industries to evaluate their business opportunities for production based on algae raw materials, and the network will strengthen the cooperation and sparring between the Nordic partners. In addition, the newsletters and the website will give a large network for algae activities in the North Atlantic area including England, Scotland, Ireland, Faroe Island, Greenland and the east coast of Canada.</p>	
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