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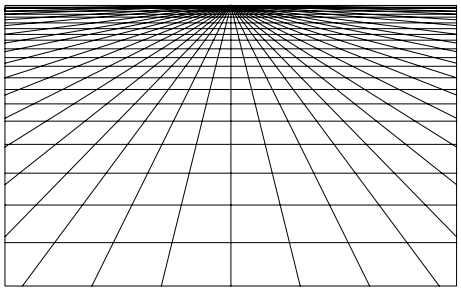

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BELLONA & HYDROGEN

- The role of mediation in technical change

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SYNOPSIS

The energy production and consumption is a major contributor to our environmental problems. The energy carrier hydrogen can be a part of the solution. In the thesis the Bellona Foundation's role in the process of technical change towards utilisation of hydrogen in Norway is investigated. Its role is analysed through the concept of mediation, which is based on seeing technical change as a social process.

Mediators connect, or build bridges between, different actors, as well as between different types of knowledge. They establish new kinds of links and create new arenas of interaction for previously separated units. In addition, or through their work, they translate knowledge from one context or domain to another. They are also processing, interpreting and combining knowledge in new ways. Mediators bring together people with different competencies, and orchestrate their efforts often on a consensus basis.

Bellona combines the different kinds of mediations, to influence the process of technical change at various levels and steps. They mediate mainly within the industry and between the industrial- and governmental domain. To some degree they also mediate between the experts and the public. But the direct contact with the public seems to be more or less absent in their hydrogen work.

It seems like Bellona's mediator role fills an open space in the realm of technology policy making. Environmental oriented NGOs will perform or combine various mediating roles differently. To be able to make socially appropriate and sustainable technical change, probably other actors than the established traditional ones should be more involved. The possibilities for public participation should be strengthened, as well as the possibilities for mediation.

Keywords: Bellona; hydrogen; mediation; mediating knowledge; technical change; environmental organisations.

PREFACE

This paper is a master thesis, in the field of social study of technology. My motivation for writing it is that years of working and studying in an exclusively technical world made me undernourished on broader and more social related issues. In particular I wanted to broaden my knowledge about the energy field. The history of the Danish energy-system caught my interest, and my stay in Denmark was fruitful in that respect. Even more was the connection to Aalborg University fruitful because of the inspiring supervising by Andrew Jamison. I want to thank him for guiding me into very interesting cross-sections of environmentalism, social movements, science and technology policy, and politics of knowledge. In addition, I want to thank The Bellona Foundation for very obliging co-operation, as well as thanking all my Danish and Norwegian friends who contributed to make this a unique year (of studying).

Oslo, December 2001

Beate Kristiansen

CONTENT

1 INTRODUCTION

Despite increased consciousness and common understanding about the environmental problems and the propagating call for sustainability, our development - in general - continues to become less sustainable. New or better technologies can solve many problems, but new ways of thinking about, talking about and handling technology and technical changes are probably even more important. In this thesis I treat the environmental Non-Governmental Organisation (NGO), The Bellona Foundation, as a potential contributor to solving environmental problems.

The energy production and consumption is a major contributor to our environmental problems, and the potential non-polluting energy carrier hydrogen can be a part of the (technical) solution to this. Thus, my particular case is *the role the Bellona Foundation plays through its work to contribute to the development and utilisation of hydrogen as an energy carrier in Norway*.

Usually NGOs are seen as marginal actors in the process of technical change. In this thesis an explicit focus is on the role of an NGO. The role is investigated as an example of what I call mediation.

When talking about NGOs in this text I mean organisations we often name interest organisations: like an environmental- or human-right organisations, or more in general a social organisation, - one that is not governmental nor industrial based, but rather based on issues or interests raised somewhere in the public. However, this thesis mostly concerns environmental related NGOs.

My main sources of inspiration have been Eyerman and Jamison's writings about social movements and Gibbons et al.'s writing about the production of new knowledge. The former say that many people have written about so-called new social movements in one way or another. "But they unfortunately contribute little to our understanding of the actual cognitive significance of social movements. What gets lost from view is the dynamic role, the mediating role that movements play in what might be termed the social shaping of knowledge" (Eyerman & Jamison 1991:47). I have also to some extent used Hvelplund and Lund's writings about the Danish energy policy in the 1970s and 1980s, to contrast the role of Bellona with the role of some Danish NGOs.

My sources have been written material, interviews, meetings and conferences. In Bellona I had mainly two informants: one on general organisational matters and one on the specific hydrogen work. In addition, I attended some meetings at Bellona, and participated in conferences – two arranged by Bellona itself and two external, where I listened to and talked to people inside and outside Bellona. Thus, I have been following an ongoing process to some degree through participatory observations.

Bellona's has just finished the initial part of its hydrogen work and plan to continue for many more years. The utilisation of hydrogen in our society is at a very early stage. However, this should not influence the validity of the investigation. Bellona's work has not just developed but also in some ways changed during the investigation period, which has introduced challenging dynamics into the study. I have aimed at a constructive contribution to the understanding of an NGO as a mediator. Thus, I have not spent much space to criticise their role. Of course there are items for potential critics like the lack of full documentation of their energy work, as well as examples of too optimistic aims with respect to time schedules. But due to very tight space limitations I have decided not to focus too much attention on such criticism.

I have performed this work as an engineer, founded on my initial technical background. Based on my instrumental relation to theory I have not aimed at giving a very theoretical presentation. I rather wanted space for telling the story.

The analytical framework to understand what Bellona is doing, the role it plays, is outlined in the next chapter. In chapter three the technical basis for hydrogen and some of its potentials and challenges as an energy carrier are outlined. Then the story of Bellona is told in chapter four. The analysis of Bellona's mediator role is performed in chapter five. Finally I conclude and give some recommendations for future work.

2 ANALYTICAL FRAMEWORK

2.1 Technical change as a social process

According to Jamison ”it can be suggested that the science and technology studies or science, technology and society, has bifurcated in recent years into two rather different types of research, that can be characterised as economic and cultural approaches” (Jamison 2001A:12), like he indicates in the table below (ref. table 2.1).

Economic approach:	**Cultural approach:**
Systems of innovation	Value or norm systems
Trajectories	Actor-networks
Firm strategies	Discursive practices
Science & technology dynamics	Contextual tensions
Policy instruments	Public debates
Evaluation tools	Participatory assessment
Instrumental rationality	Communicative rationality

Table no.2.1 *Approaches to science, technology and society studies (Jamison 2001A:12)*

I agree with Jamison’s attempt on structuring this field. The most interesting is that this representation elucidates the interests or motivations behind the approaches. The two types of approaches have different focus, different things are seen as important. The dominant tendency is to approach technical change through economic approaches – mainly through the notion of innovation. But there are other aspects that might be even more important than

the economic if the technology is to fit into the society, into cultural patterns and into a social context. Therefore, I have chosen to base my conceptual or analytical framework for the analysis on approaches or concepts that relate more to the cultural; not on more economic or management related approaches as for instance the 'system of innovation' approach (Lundvall1992; Isaksen 1997; Gregersen 2000).

In accordance to the table above the economic, or business- or management-oriented approaches seek to elucidate firm strategies and technology trajectories, like innovation systems, economic procedures, and selection mechanisms focusing on instrumental relations, primarily in order to evaluate the effect of different policy instruments. The cultural, or sociological, approaches, on the other hand, attempt to identify the values and discourses that are at work in the world of policymaking (Jamison 2001A).

'Technical change' is often seen as equal to 'innovation'. The notion of innovation is used and interpreted in various ways. Usually it comprises the part in which a new or improved artefact is turned into something marketable. However, it can be found to be interpreted broader or narrower, comprising purely the technical aspects and to include organisational and institutional changes (Edquist 1997:119). In addition, the processes of implementation and diffusion are sometimes included and sometimes not. But regardless of the interpretation usually it is connected closely with economics:

> An important part of this understanding [of the process of technical innovation] relates to economic aspects of the process, such as cost, return on investment, market structure, rate of growth and distribution of possible benefits. We still know far too little about these economic aspects of innovation,... As our knowledge extends so does the possibility of using innovations more satisfactorily. (Freeman 1997:17)

The actors that are seen as significant for the innovation and are included in innovation systems are usually established actors i.e. governmental-, business- or academic related actors.

> The essence of the 'system of innovation' is that the overall innovation performance of an economy depends not only on how specific organisations like firms and research institutions perform, but also on how they interact with each other and with the government sector in knowledge production and distribution. (Gregersen 2000:5-6)

Neither a definition of the concept of 'national system of innovation' in a broad sense like:

> All parts and aspects of the economic structure and institutional set-up affecting learning as well as searching and exploring - the production system, the marketing system and the system of finance represent themselves as subsystems in which learning take place. (Lundvall, 1992:12)

does leave much room for public- or grassroots based engagements.

Through seeing technology or technological change as a social process, I will argue that if we want to increase our knowledge about the innovation process we should include other approaches than the economic as well as other actors than the established firms and organisations.

> It is regarding development of a society's innovation ability important to keep an eye on economic independent groups, which can be sources of inspiration and catalysts for the necessary technological changes. (Hvelplund & Lund 2001:212)

Based on the experience from the change in the Danish energy policy the last 20 years these authors write:

> It is an interesting lesson, that the established firms and organisations which dominate the media with their talk about what is economic for the society, actually talk about what is most economic in short term and just for their own activity and members. And they often succeed to make the public believe that this is the most economic for the society as a whole in the long run. (Hvelplund & Lund 2001:194)

Seeing technology as a social process is based on seeing technology as socially constructed or shaped. Wiebe Bijker, a central person in this field, puts it this way "…an artifact does not suddenly appear as the result of a singular act of heroic invention; instead, it is gradually constructed in the social interaction between and within relevant social groups" (Bijker 1995:270). This field or approach, or rather approaches, emerged as an answer to the old technological rationality, a more technology deterministic view. Here technology and the development of technological solutions were seen as more or less "constructed by itself", having a life on its own and rather impossible to control, a treadmill of production or unstable practice (MacKenzie & Wajcman 1999:3-27).

When talking about technology as a social process, it can be seen to consist of various processes. Technology is a complicated process, difficult to interpret and to have a comprehensive concept for. However, one way to think about these processes is as four different ideal types of technology relating to ideas, actors, arenas and the artefacts (Jamison 29.03.01). The table below illustrates this (ref. table 2.2).

"Ideas":					
(Basic)Research	Experiments	Application	Promotion		
"Actors":					
Researchers/scientists	Engineers	Entreprenures	Managers	Brokers	Public
"Arenas":					
Labs	Workshop	Factories	Media	Shops	Homes
"Artefacts":					
Invention	Development	Innovation/implementation	Diffusion	Appropriation	

Table no.2.2: *Technology as a social process (After Jamison 29.03.01)*

There are different levels, steps, phases or parts in the process of technological change. As well are there different sort of people involved in the different parts, and the various work is performed at different places in the society. I prefer using the term parts, instead of steps or phases since those give an idea of a linear process, which the process of technical change rarely is. Obvious, technology has an 'artefact' related process, which is the main way for example engineers think about technology. Here the artefact goes through a process, not necessarily linear, of invention, developing, implementation, diffusion (where more or less of these parts are termed innovation) and appropriation. In addition to invent, develop, innovate and diffuse our technology, we also have to make some kind of attempt to see that the technologies we have are appropriate. What often happens at our innovation policy making is that the emphasis does not include the appropriation-part. It is not any real policy concern about this or enough support for what one might call the agents of appropriation, who often are trying to represent various kinds of publics who are not properly represented.

I will emphasise the need for connecting or bringing these parts, processes, actors and arenas together to make the technology appropriate. To end up making the right technology in the right way so both the making and the final product fits into and is good for the society

and its users; the users' or society's requirements should be emphasised through out the whole process of technical change. As we will see Bellona play a role in these respects. Therefore, I see other actors than firms, research institutions and the government sector as contributors to the knowledge production concerning technical change, and choose to see the NGO as a technical actor. This is inspired by the concept of cognitive approach to social movements, where the social movements are seen as "creative forces in society, as sources of inspiration as well as new knowledge" (Eyerman & Jamison 1991:58).

We find that former NGOs, also before this notion was used, that constituted some sort of social movements, played a certain role in the field of natural science and related matters. Scientific knowledge might be seen to directly dependent on social movement. In the seventeenth century the idea of science and experiments arose in religious "movements" in Britain (Merton 1970). And about the social movements of the nineteen-century Jamison says:

> …social movements in the nineteenth century, with the growth of the labour movement in Europe and populism in America, also had an important influence on knowledge-making……. many of the revolutionary innovations that were to fuel the second industrial revolution … - electricity, organic chemistry, internal combustion engines, airplanes, moving pictures, the automobile - were motivated by populists or socialist impulses. (Jamison 2001B:56)

About our days he writes:

> Out of the anti-imperialist and student movements in the 1960s and the feminist and environmentalist movement of the 1970s and 1980s have emerged a range of alternative ideas about knowledge, in form, content, and meaning, that has given rise to new science and technological programs. (Jamison 2001B:58)

After the energy debates in the 1970s environmental concerns have got more incorporated into the established political structures. In many European countries, university departments and research institutes, as well as state bureaucracies[1], which have an interest in environmental and energy issues have been founded. Environmental concern has increasingly been integrated into corporate planning and innovation strategies, and many management and engineering schools do now provide training in environmental economics, as well as in new methods of "cleaner" production.

Connected to technology development, or technological changes, are production of knowledge and science. A clear-cut distinction between these expressions is difficult to make, and for the purpose of this thesis it should not be important to do so either. However, there are various definitions of what is science and what is technology. (See Asdal *et al*. 2001:9-10; Jary *et al.* 1999:576&678). I consider science and knowledge achievement as a fundament for or an input to development of various technological solutions, and that knowledge production and technological development often go hand-in-hand. - New knowledge can change the technology and new technology can give new knowledge.

By seeing technology as a social process, I also see knowledge production as a social process, where knowledge is produced through various actions and interactions in the society. Thus, I see the NGO as a technical actor producing technical knowledge, constituting all relevant knowledge for the (social) process of technical change. Studies have shown that NGOs have conditioned new ideas and initiations of changes in the energy sector, as well as implementation or diffusion of energy technology (Jørgensen & Karnøe 1995; Ornetzeder 2001). It seems like traditional actors can be locked in traditional ways of looking for solutions and opportunities.

[1] The Norwegian ministry of environment was founded in 1972.

Technical changes depend on social negotiations, where tactics, strategies and power are enforced. In these processes radical technological changes will meet resistance from the established organisations and institutionalised infrastructure on the market. Some of the resistance has been described as: the battle about the problem-definition, the battle for entering into the arenas of discussion, and the battles to be recognised as technical realisable, significant and economic. (Hvelplund *et al*. 1995:78-81).

There are many strong forces in the process of technical change exercised by actors with different interests and incentives for participating in or contributing to the process. The participants or actors are to a large extent, shaped and influenced by the context in which they work, and will often look upon given situations in different ways. The main actors in science and technology systems have been identified in terms of the four ideal typical policy cultures, or policy domains: academic, bureaucratic, economic and civic (ref. table 2.3). (Jamison 2001A:12).

	Bureaucratic	**Economic**	**Academic**	**Civic**
Principle:	order	innovation	enlightenment	accountability
Steering mechanism:	planning	profitability	peer review	assessment
Ethos:	Formalistic	Commercial	scientific	participatory

Table no.2.3 *Cultural tension of science and technology policy (Jamison 2001A:13)*

The further development of the analytical framework will be based on a somewhat modified version of these domains. Jamison uses them for the purpose of describing the process of science and technology policy making in general. Here they will be used more for the purpose of describing roles and interaction in the process of a technical change. The

economic domain will be called the industrial domain, and consists of industrial and financial actors, including industrial R&D (research and development) departments. The main concern in this domain is profit, and their interests are usually innovation related. The bureaucratic domain will be called the governmental domain, and consists of state ministries and agencies, authorities, laws and regulations, and politicians in general. The academic domain consists of more or less public founded or supported R&D institutions. To a greater degree than actors from the other domains they concern themselves with more basic research, and develop science and technology more for its own sake. The civic domain consists of the people, and is often represented by NGOs and sometimes by the local government. They generally seek an integration of the right - appropriate - technology into society.

Clearly the actors will have different focuses on a given matter and have various degrees of incentives to contribute, push or pull in relation to a process of technical change. Thus, there is a need for bringing domains together at different levels, and as we will see in the next section, this is what mediation is about.

2.2 Mediation

Mediators are those who establish new kinds of links and create new arenas of interaction for previously separated units. Mediators are facilitating bridge- or network building. They are connecting people or actors to negotiate interpretations, ideas and solutions. Through their work they serve as translators. They transfer a certain language or conceptual framework that has been developed in one sphere of knowledge production into another, like transforming everyday knowledge into professional knowledge and providing new contexts for the reinterpretation of professional knowledge. As well they are processing and interpreting knowledge, and combining it in new ways – also called hybridisation. Mediators

bring together people with different competencies, and often orchestrate their efforts on a consensus basis. The meaning of this will be interpreted and exemplified in this section, along with the development of the approach for the analysis of Bellona's role.

There are many examples of gaps or interfaces between various groups or cultures that need mediation of various kinds. My experience from project work in the oil and gas sector tells me that the reason for a failure has almost always something to do with an interface – an interface between departments, project-groups, professions, levels etc. And when Fatma Jynge, a Norwegian woman who managed some of the few relatively big public projects[2] in Norway that were finished on time and under budget, tells about what she sees as the three most important criteria for success, she says: interface, interface, interface (Brunvoll 29.10.01). She focuses on the various interfaces all the way through the project.

These cases deal with project management but I think there are parallels to all sorts of interfaces in the society. The challenges in interaction and communication are very much the same: differences in culture, focus, language, way of talking, interpretation of a problem and so on.

People from different disciplines have difficulties understanding the exact content of each other's problems. They interpret and see the reality in different ways. Just the interpretation of words and expressions can make problems. An informant in the PESTO project puts it this way:

> If you talk to a wood person and say bioenergy, he interprets that as a heap of chipped wood. If you talk to bacteriologists, they mean bacteria which produce hydrogen. If you talk to a mechanical engineer they mean a steam turbine in which you burn wood to produce electricity, etc…… all

[2] I.e. moving of the military plant from Gardermoen to Rena.

> the time you must continuously interpret what is being said. (Jamison *et al*. 1999:35)

This example just shows communication problems within technically related discipline!

Nevertheless there is a strong need for co-operation between various groups and interests to obtain good solutions to complex problems. The need is increasing with the growing complexity of our society. Thus, there is an increasing need for cross-profession-, cross-institution-, cross-culture-, cross-border work etc., and it seems like we are not handling this well enough. I want to see how an environmental NGO approaches this, the sort of role it plays to contribute to handling this challenge.

In the early phase of the environmentalism it was much about opening up spaces for identifying, formulating and discussing new societal problems like chemical risks and air pollution. The post-war mode of techno-economic development, with its dependence on science-based innovations and its relatively unproblematic view of science and technology were shown to have serious “side effects”. The environmental movement was *mediating knowledge* in the sense that it translated the ecosystem ecology into societal terms. They “transformed a scientific theory into a way of life, but even more perhaps into a set of beliefs” (Eyerman & Jamison 1991:73), which Eyerman and Jamison also call “the ecological worldview”. In addition, the movement wanted to develop new and more democratic forms of knowledge production, and did this through dissemination of scientific information and popularisation of ecology. In science we got ecologists and ecological theories. Outside science among others, ecological philosophy by the Norwegian Arne Næss, ecological theology by the Danish Ole Jensen, and ecological politics occurred. “There was no talk before the environmental movement began to put its ecological cosmology into practice, of ecological living or ecological lifestyle or even ecological poetry” (Eyerman & Jamison

1991:73). The movement opened up and mediated space for those types of knowledge and experience to be able to emerge.

"..by spontaneously responding to new social problems, indeed often formulating those problems for society, social movements create spaces for new explanatory intellectual activities to crystallise" (Eyerman & Jamison 1991:106). New types of intellectuals, "movement intellectuals" as Eyerman and Jamison call them, began to mediate knowledge through translating the concerns of critical scientists into counter knowledge, popularising knowledge, and making new everyday engineering solutions practical. They acted as so-called 'counter experts', 'grassroots engineers' and 'public educators' (Eyerman & Jamison 1991:104-106). The Danish Organisation for renewable energy (OVE) which worked against nuclear power, acted as counter experts by opposing politicians and the powerful electricity companies. They also acted as grassroots engineers in the sense that participants built privately owned wind-turbines, and weekend seminars were held, where practical technical knowledge and thoughts were exchanged. As public educators they held public meetings and popularised the messages. OVE together with other Danish NGOs at that time, played these roles in the battle against nuclear power, advocated by big electricity companies, forces in the Danish governmental ministries, the trade union – Dansk Metal, and the interest organisation for the industry – Dansk Industri (Hvelplund & Lund 2001:193). The NGOs were in favour of the use of renewable energy sources, especially wind power. And they won! As the only country in the world Denmark has decided by law that they will not use nuclear power (Lund 31.05.01).

One of the sources of inspiration for this work, Gibbons et al.'s book about the change in knowledge production, also talk about knowledge mediation.

> Access to knowledge and expertise, reconfiguring it in novel ways and offering it for sale, are becoming specialised functions and new mediating

> organisations are being set up to fill this gap. The demand is for much more than data or information, however technical it is, for knowledge, for the identification and solution of problems. (Gibbons *et al*. 1994:117)

In relation to what they call "the new production of knowledge", where interfaces are blurred; the mixed disciplines, backgrounds, contexts for use and production etc., as well as knowledge being more embodied in people, there is a need for new forms of mediation.

As the early phase of environmentalism was about opening up spaces for mediation of knowledge, it is now more about making something happen. In a way it has moved into a commercial period. Arne Næss, who himself started to develop an ecological philosophy in the 1970s and has followed the development in the environmental movement the last 40 years, expresses it this way "I just gape about what Bellona has performed and achieved compared to what I myself and my contemporaries achieved." (Næss 14.06.01). Making concrete and practical things happen is usually conditioned by actors actually meeting and co-operating. Current environmental NGOs do also often contribute to facilitate interaction and links between actors – *mediating connections between actors*.

The specific roles to be investigated are knowledge mediation and mediating connections, or more in general, gaps between actors. However, these mediator roles do not usually occur as distinct roles. They are often executed in parallel, have a common area and are interdependent. For example transforming or translating of knowledge, which can be seen as a part of knowledge mediation, can act as a means for bridging separate groups (ref. figure 2.4)

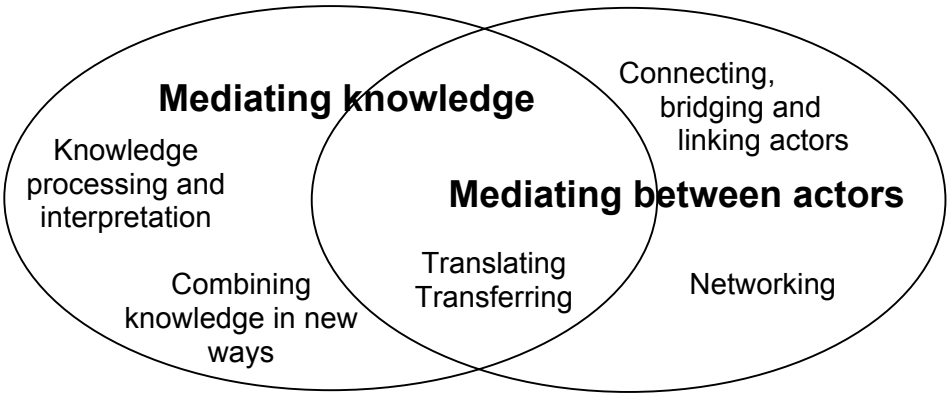

Figure 2.4 *Mediation.*

Another sources of inspiration, is the concept used for the analysis in the PESTO project when investigating the process of "pragmatisation" performed by various types of "brokers". Pragmatisation was understood as the process of translation and interpretation – transformation from visions to practical solutions, which simultaneously involve connecting people with different competencies, interests and agendas. It was seen as a part of the process of ecological modernisation, the continuo adaptation of "sustainability" to "business as usual". (Jamison *et al*. 1999:25-26). The PESTO research project identified the various brokers as organisers of networks, as translators or interpreters of the "story lines" of sustainability, and as brokers in business like in management and as entrepreneurs. The researchers aimed at understanding the forms of network building and brokerage that took place. They wanted to "elucidate the new social network which increasingly, and in variable ways in different countries, influence science and technology policy making" (Jamison *et al*. 1999:26). I see the NGO, Bellona, as a part of this new social network.

Others have also written about brokers, like Johan Schot, saying that brokers bring together people with different competencies, and orchestrate their effort for their own ends in particular projects (Jamison *et al.* 1999:26). Gibbons et al. use the notions 'problem brokers'

and 'strategic brokers' in relation to their investigation of the change in knowledge production, without really defining them. However they say:

> Brokering is necessary because in distributed knowledge production more actors, not all technical experts, are involved. Brokering will demand exceptional skills because the individuals involved in the innovation process will come from many different institutions and organisations, they will often be dispersed geographically and may only be able to work on a problem or project part-time. (Gibbons *et al*. 1994:162)

To some extent the mediator role corresponds to the broker role in the sense of translation, interpretation and connecting people. However, the broker is mostly emphasising network building and connecting new combinations of people. While the mediator, as we will see, more explicitly also is mediating knowledge. Another thing is that the mediator is not in it just for the money. A mediator has to a greater extent social- and environmental goals. They have different motives for performing their connector or transferring role. Therefore, the economic and business related broker role is not a suitable concept.

There are various examples of organisations or institutions that act as mediators between actors or domains. With respect to knowledge mediation in general, Gibbons et al. point out:

> Knowledge producing, knowledge mediation and knowledge diffusing institutions have proliferated since 1945. Universities and university-like establishments of higher education, professional societies, governmental and corporate R&D laboratories, consultancy firms and think-tanks, non-governmental organisations and other advocacy groups have multiplied and continued to create their own markets for knowledge. (Gibbons *et al*. 1994:136)

For the interface of research and companies, there are transfer offices at universities that either aim at commercialise their knowledge or just make it more available for the society. Or they might also aim at industrial needs as background for work on thesis[3]. In Norway there are various programs for mediation of technological knowledge in particular. There are the FORNY (innovation and commercialisation from R&D environments), ENT (establishing new technology) and NT (innovation and technology program for the north of Norway). They aim at facilitating spin-off effects from R&D work or diffusion of technology to outlying regions.

However, in this thesis I will look into the following four gaps for mediation:

- Between actors in the governmental domain and the industrial domain.
- Between actors within the industrial domain.
- Between the public and the experts.
- Between technical specialists.

A mediator that acts at one interface might as well acts at another. These are ideal types of mediators, thus, various combinations might be performed by one and the same actor.

Mediation from the industry to the governmental domain often takes place as lobbying. The purpose is to influence what sort of frame conditions or strategies, like laws, regulations, taxes, subsides, research programs, available resources, aims and objectives etc., that the politicians are establishing for the industry, as well as resolutions regarding technical changes in society. Many such activities going on at this interface, are performed by more or less dependent or partial actors like industrial or technical interest organisations, like NHO (the employers' interest organisation in Norway) or NAF (the Norwegian automobile association). Mediation of knowledge the other way might be performed by governmental

[3] Like the Science shop (vitenskapsbutikken) at the university of Oslo.

information sources, like the Ministry of Environment and Energy's information centre – the Environmental shop in Copenhagen. It provides information related to environment and energy and on Danish legislation and policies, for enterprises as well as for all interested citizens (Environmental shop's web-site).

However, the mediators I think of are not directly related to the given domains. For example the Danish researchers Frede Hvelplund and Henrik Lund, employed at the Aalborg university in Denmark, were mediating this interface through their work on the alternative energy plans. They transformed technical possibilities into political strategies. The first draft of an alternative energy plan[4] was made in 1976. In 1990 this alternative energy politics, which was based on renewable energy, energy saving and power-heat combination plants, became the official energy plan. (Lund 31.05.01).

Mediating within the industry, between companies including their R&D departments, might facilitate exchange of information and knowledge for example about technological status and possibilities. This could be performed through facilitating connections, network building or co-operation through arranging contact, meetings, conferences etc. A company's network-building is often facilitated by people within the organisation or through engagement of consultants, by brokers, and their motives are usually economically based. As we shall see, there are also examples of a more independent actor performing mediation at this interface. In the process of problem solving involving different companies usually common solutions and joint agreements are required. In these cases the mediators facilitate consensus and mutual understanding. Through their interests in results rather than in income, the mediators

[4] OVE and OOA (organisation for information about nuclear power) gave out the alternative energy plans.

should have incentives for facilitating the process all the way to the results. Because usually just making connections or agreements are not enough to achieve results.

Technical knowledge from the R&D- and the technical environment that can be useful for the public can sometimes be rather inaccessible. It might be that it is difficult to find it, to understand it or see the practical use of it. Often there also are gaps between the public's demands and what the experts are doing and making "for" them.

The Norwegian Environmental homeguard (MHV[5]) aims at public mobilisation about everyday life, consumption and environment. They want to give clear, easily understood and popularised information about more environmental friendly choices and actions in daily life for groups, organisations and institutions (MHV's web-site). OVE and other Danish NGOs in the 1970s and 1980s mediated between the public and the experts, through their engagement for broadly emphasising public requirements and making spaces for the public to fight for their opinions. They also transferred and translated technical knowledge. Through the work for developing alternative energy solutions they translated public demands into political strategies. Their main philosophy was that the solutions should be locally rooted, symbolising democratic ideas and sharing of knowledge. They "gave birth to many entrepreneurial ideas and created an institutional framework that nurtured the development of the modern wind-turbine and the wind-turbine industry in Denmark" (Jørgensen & Karnøe 1995:57-58). Their bottom-up strategy emphasised experiments with small wind-turbines first and gradually became better at that, and then built successive bigger and bigger. Another, top-down, strategy defended by the big electrical companies, aimed at developing and building big wind-turbines (about 10 times more output) right away. The bottom-up strategy has certainly beaten the other strategy. It reached the point quicker of making a big wind-

[5] formed in 1991, constitutes of the main Norwegian public organisations with about 24000 local units.

turbine that worked. All the current wind-turbine export[6] is based on the wind-turbines developed under that strategy. (Lund 31.05.01). Other countries have also gone for this top-down strategy without much luck.

> This top-down strategy was based on a science-push logic. Its lack of practical results can be seen in Sweden, Germany, and the United States where the investment of billions of U.S. dollars did not bring about commercial viable wind technology, or even a usable concept for further development. (Jørgensen & Karnøe 1995:58)

Shown by the PESTO example above, there might be great gaps between different technical fields that require some sort of mediation. To handle complex solutions, like an integrated infrastructure of natural-gas, CO_2, hydrogen and electricity, in the change towards a hydrogen based energy-system, cross-profession and cross-field work is required. This involve the often distinct fields of offshore and onshore, as well as about every technical discipline, like mechanical, process, subsea, reservoir, chemical, material, civil, electrical etc. A comprehensive solution of this sort requires connection and knowledge mediation at various interfaces. Mediating between technical specialities often also amounts mediating between firms or companies within the industrial domain.

[6] Currently constituting a significant part of the Danish export. From 1994 to year 2000 the export of energy technology increase from 4 to about 20 billions DKr.

3 HYDROGEN[7]

3.1 Introduction

To understand what Bellona is doing and aiming at in their hydrogen work, and get a better bases for analysing Bellona's role in the hydrogen-field, I have looked briefly into 'hydrogen'. This chapter comprises short descriptions of what hydrogen is, potential areas for use, and some hydrogen technology.

The thought of hydrogen as an energy-carrier is not new – it was introduced by Jules Verne already in 1874, in the book "L'Ile Mysterieuse". Hydrogen was a common fuel in the early generations of engine driven vehicles. It has also previous been utilised for transportation purposes in air balloons and air ships. But it was the oil crisis, about thirty years ago that again lead to increasing interest for hydrogen. In the 1970's we looked to hydrogen and renewable energy solutions to secure the energy supply. Presently we are focusing on the matter more for the purpose of environmental problems due to the extensive use of fossil energy (ref. figure 3.1 & 3.2).

[7] The sources for this chapter is mainly (BMW group 2001), (Energistyrelsen 1998), (Hart *et al*. 1999), (Hart 1997), (H_2-Forum), (Kruse & Hustad 2001) and (Palm *et.al.* 1999).

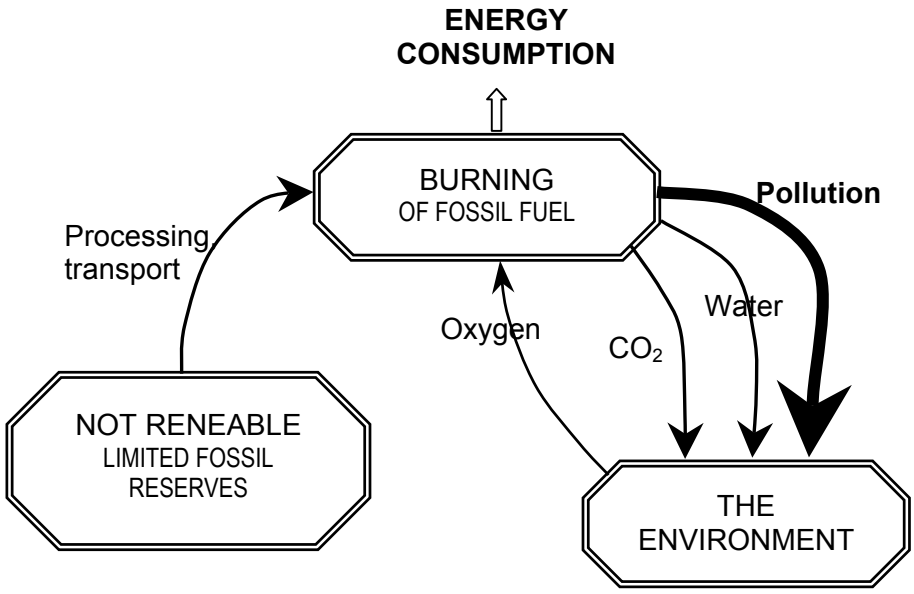

Figure 3.1 *Fossil-based energy-system. (After H_2-forum:5)*

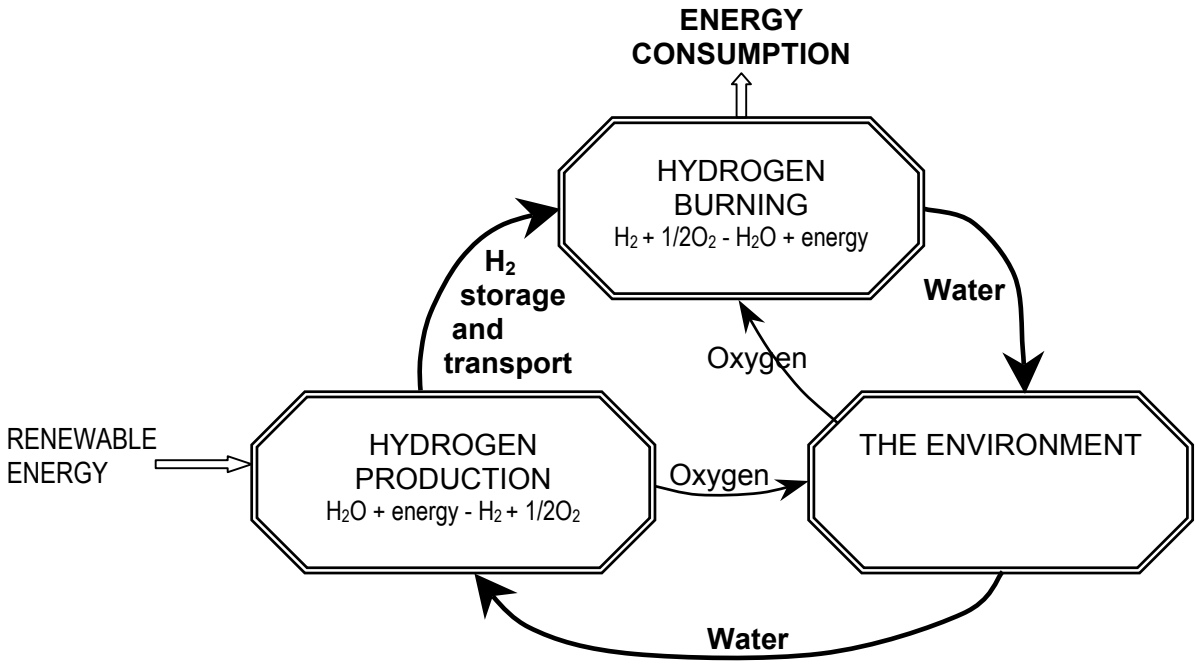

Figure 3.2 *Circuit with hydrogen as the energy-carrier. (After H_2-forum:4)*

Hydrogen is not an energy source in itself that can be extracted and serve as primary energy. It is rather an intermediate stadium in a number of energy transformations between primary source and end use (ref. figure 3.3)

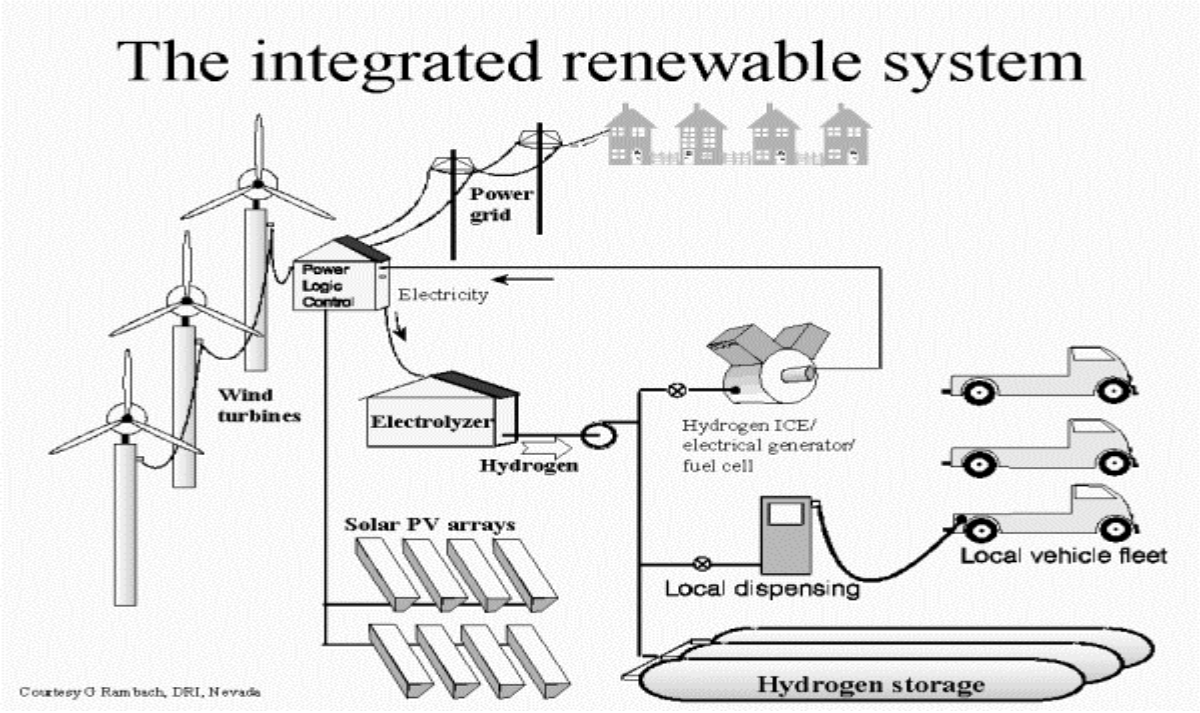

Figure 3.3 *Example of an energy-system based on hydrogen as the energy-carrier and renewable energy sources (Kruse 26.06.01).*

The possible potential for hydrogen can be imagined when we know that hydrogen can be produced from water, and is converted back to water when the energy content is utilised (ref. figure 3.2). Thus it can, in principle, be a totally environmental friendly and non-polluting fuel. However, the degree of environmental friendliness is dependening on how it is produced. But, on the way there are many “stones to turn” and paths to choose between. The following text will give some insight into these possibilities and challenges.

3.2 Areas for use

Many nations are looking at alternative energy sources like renewable sources as sun and wind. Because such sources have production variations during the day and the seasons, and because of often long distances between the energy source and the user, appropriate mediums for storing and transporting of the energy are required. For both these purposes it might be of interest to convert the energy to hydrogen. Compared to electricity hydrogen is more suitable for storing, and in some cases also better for transportation of energy with a potential for improvements, dependent on the technology development.

The early use of hydrogen and hydrogen based fuel-cells are seen and foreseen to be in sectors like transportation; telecommunication; portable electrical equipment – instead of batteries; and power stations.

In addition to the environmental advantage, hydrogen as a fuel has several technical advantages. Fuel-cell driven engines will have higher efficiency than the commercial internal combustion engines, more of the energy in the fuel is utilised and less is lost. The efficiency is especially higher in city traffic, because of the fuel-cell engine's better characteristic at low velocities and zero fuel consumption when stationary (it has no idling). Hydrogen used as fuel in ordinary flying would give increased cargo capacity and longer range. Thus it is better than conventional air-fuel seen from a technical and environmental perspective, but it has not yet been considered economically competitive.

Hydrogen is currently used in a number of industrial processes, such as computer, metallurgical, chemical, pharmaceutical, fertiliser and food industries (H_2-Info 2001). The sale of hydrogen has increased by 6% every year the last 5 years, mostly due to the increased

consumption of hydrogen in refineries because of stricter requirements to fuel quality. This consumption is assumed to increase. In addition, a marketable increase is expected the next years, in local small-scale production of hydrogen as the fuel-cell technology is introduced on the marked. (Heydorn 1998).

The space programs have contributed to develop the key hydrogen technology. Fuel-cells were first used in the 7 space ships in the American space-organisation, NASA's Gemini-program in the 1960's. In the space ships of today fuel-cells supply all the electricity onboard, and the water produced from the process in the fuel-cells is used as drinking- and cooling water. The space ships are also using hydrogen as fuel for the main engine under take-off.

3.3 Technical status

Hydrogen can be produced from water as well as from different fossil fuels like coal, oil and natural gas. To be a total environmental friendly energy carrier, the electricity used for splitting the water should come from renewable energy sources, such as sun, wind etc. Any discharge of carbon dioxide when using hydrocarbons should be taken care of and not vented out to the atmosphere. Hydrogen can also be produced from different types of bio-masses. The CO_2 from such process balance the CO_2 consumed during the growing of the bio-mass.

45 million[8] tons hydrogen is produced in the world every year. More than 90% of this is produced from fossil fuel, with natural gas as the dominant raw material. Under such

[8] Number from 1996.

processes CO_2, which usually is discharged in the atmosphere, is formed. However, there is research going on about ways of handling the CO_2, such as underground depositing.

The production of hydrogen can be adjusted to the variation in electricity consumption. Thus, the electricity can be utilised for hydrogen produced when the electricity consumption is low. In addition, hydrogen can be produced locally, from the energy sources bio-mass, wind, rubbish, sun, algae, tide etc. Such decentralised hydrogen and/or power production has the potential of being a more democratic energy-system than the one we have to day.

Norsk Hydro has calculations that show that it is currently cheaper or about the same price to produce hydrogen as gasoline independent of taxes, but dependent on the price of electricity[9] (Cloed 14.06.01). The normal trend is that price decrease with mass production, like it has done for production of for example sun-cells.

When hydrogen is burned, turned into energy, only water is formed. It can be burned more or less directly for heating purposes or in a turbine or combustion engine. However, in a long-term perspective the most interesting technology for converting hydrogen to energy is the fuel cell. Different types of fuel cells for electricity production, and in some cases also heat, are developed and under development. Into a hydrogen fuel cell, oxygen or air and hydrogen are introduced and you get electricity and water. It is the chemical energy between the two electrodes (hydrogen gas and oxygen gas or air) that is transformed into electrical energy when the ions move through the electrolyte – a membrane that separates the two electrodes. And the electrons move back via an electrical cable. The fuel cells used in Gemini, Apollo and space ships had relatively short lifetime and had parts of expensive metals. New membranes and technology that give less need for platinum and thereby decreasing material

[9] Capital cost is 20-30% and energy is 70-80% of the production cost. Electricity price of 10-20 øre give a lower price for hydrogen than for gasoline, electricity price of 25-30 øre give a bout the same price or slightly higher.

cost have been developed and the technology is still being improved. For the time being the production of the fuel cells is a bottleneck, however, the main fuel-cell producer, Ballard Power Systems, is going to open a new factory soon.

In addition to the environmental advantages, the positive traits of fuel-cells running on hydrogen might be that they are relatively quiet, efficient, light and have relatively long lifetime, and there are usually no moving parts which make them relatively reliable in operation. The main negative trait is that they are still relatively expensive, however, this is expected to decrease with mass production and further technical development.

For transportation and storage purposes the density on the hydrogen has to be increased. In natural atmospheric condition an amount of hydrogen gas for energy purposes will take up unduly space, therefore, hydrogen is usually either stored compressed - under pressure, or liquefied – cooled down. However, these solutions are not totally satisfactory. Sometimes the weight of the pressure tank or keeping the hydrogen below the boiling point (at – 253 ^{o}C.) is a challenge. However, the insulation that is developed works well for various purposes, and lighter modern composite materials are introduced. For storage of large quantum using underground storage like salt caverns, former reservoirs etc. is considered. Another problem is that the current technology for the condensation process requires much energy, about one third of the produced, but there are research on potential improvements on the technology.

Research is performed on other ways of storing hydrogen too, like storage in metal hydrides, in nano-fibre, in carbon and more. Here are great potentials for closer packing of hydrogen atoms and a less voluminous and a lighter storage solution. Solid material can be handled without many problems under normal pressure and temperature. In Norway IFE (Institute for energy technology) has long tradition in research on metal hydrides. But it is likely to take some time before such solutions are commercially available.

Until now the prototype vehicles have either stored compressed hydrogen gas on the roof[10], or in liquefied hydrogen in insulated tanks[11]. Usually, compressed hydrogen gives the vehicle a shorter range than a corresponding gasoline driven vehicle.

All types of fuels are liable to catch fire and explode. However, different fuels have different traits and should be handled differently. Hydrogen, for example, will evaporate immediately when leaking and it burns in air, while gasoline burns on the ground.

Resent studies conclude that hydrogen is safer or at least as safe as the fuel we are using to day. Linde has performed so-called worst case studies, and all cases are evaluated to be ok (Hjerpaasen 14.06.01). Some would say that today's fuel is very dangerous because it is burning "as hell" (Wagner 14.06.01). The IEA (International energy agency) Greenhous Gas R&D Hydrogen 1999 found that a gasoline car will burn for 20-30 minutes while a comparable hydrogen car will burn for 1-2 minutes.

Hydrogen is believed to be especially dangerous, because it is associated with oxyhydrogen gas[12], hydrogen bombs and the accident in the airspace "Hindenburgh" in 1937. NASA concluded that hydrogen did not play a role in the Hindenburgh accident. People jumping overboard caused most of the deaths, and the fuel (diesel) fire caused some deaths (Bain & Schmidtchen 2000). The "Challenger" accident in 1986 had no specific connection to the hydrogen that was used as fuel.

Great amount of hydrogen has been handled in the industry for years, and common city-gas that has been used many places in the world, contains about 50% hydrogen.

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[10] Like Ballard's NEBUS.
[11] Like DaimlerChrysler's NECAR (NewElectricaCar), a Mercedes A-model.
[12] "Knallgass" in Norwegian.

3.4 Current situation

The USA, Canada, Japan and Germany are the countries where most resources are spent on hydrogen related research, and California is in the front (Hjerpaasen 14.06.01). The authorities in California has decided upon a law that requires 2% of all the cars to be zero emission vehicles (ZEV) in 2003. Germany aims at a successive increase in the share of their energy consumption coming from hydrogen, starting with about 5% in 2010 (Palm 14.06.01). Iceland will remove all use of fossil fuel in 30 years. Also other like Canada, EU, Italy, Switzerland, France and Norway are performing some hydrogen technology related work.

The big actors like BMW, BP, and Shell have visions about hydrogen. Many big car companies have tested hydrogen-fuelled cars for a long time. DaimlerChrysler, GeneralMotors, Ford, Toyota (Kruse 22.06.01) and Honda (Grinna 12.02.01) say they will have fuel-cell cars for sale from 2004 or before.

BMW has developed several prototypes of hydrogen cars based on combustion engines. They have now reached the fifth generation research vehicle, with 205 Hp that can make more than 200 km/h. It has fuel-cells for the electricity supply. They have said that they are practically ready for series production - ready to go beyond research status (Wagner 14.06.01). The further development they will do prior to commercialisation is connected to storage of hydrogen for mobile use. They work on liquid hydrogen tanks, presently giving the longest range. Such tanks are in commercial use in the chemical industry.

You can find some hydrogen filling stations. For example, Honda has one in Los Angeles, and in the airport in Munich there is a filling station, which supplies the airport busses. And

filling stations are being planned, for example is Norsk Hydro in co-operation with two German companies about to develop the next generation of filling stations, and will supply the first filling station on Iceland, next year. This unit should just be connected to water and electricity supply, and will provide busses with hydrogen fuel. As well are they about to produce fuel cells that can replace 12V batteries. (Cloed 14.06.01).

In Norway several demo-projects for production and use of hydrogen are planned in order to achieve insight and experience the possibilities, hinders and timing with such technology – get knowledge about how to approach such a technological change. However, the financial aspect of many of the projects is not sorted out yet.

From those involved with hydrogen it seems like there is a rather unison YES as an answer to the question of: is hydrogen going to be a significant medium in the world energy-system? The technology director Jon Brandsar in Statkraft, and many with him, says, “it is just a matter of time before hydrogen as an energy carrier become a competitive alternative to fossil fuel and batteries” (Kruse, 26.06.01). How long time it will take depends on a range of conditions, like economy, the environmental pressure, what sort of political means that are used, how long time the building of the infrastructure will take etc.

Another relatively unison voice, which comes from the car makers, says that there are many other actions that need to be taken to get the technology utilised and to work in the society. Standards, laws and regulations need to be set. Participation of other actors are required, not just the carmakers (Wagner 14.06.01). Various kinds of collaboration constellations are formed. But some actors are less represented. In many countries firms and companies are especially asking for engagement from the authorities and the governments. In Norway companies generally ask for more long-term policy with predictable conditions with respect to taxes, goals and other political means.

Norway with its oil and gas resources as well as its industrial experience might gain in participating, and many also say by being a forerunner, in developing a hydrogen system for production and utilising hydrogen. For Norway it could be interesting to make hydrogen from natural gas, by decarbonising the natural gas and deposing the CO_2-gas, reinject it into oil fields. “All the technology included in this [the “Integrated reformer combined cycle technology” or often called the CO_2-free gas power plant] is now developed and commercial available” (H_2-forum:12). Norwegian industry has for many years produced hydrogen on a large scale by using water-electrolysis based on waterpower. Norsk Hydro masters the technology and is a marked leader within industrial water electrolysis pipes. They also know how to produce hydrogen from natural gas. On this matter Kværner has contributed with the creative Carbon Black-process. The conditions for hydrogen export through pipelines are good, and Norwegian ships that are in the forefront on gas-transport internationally, could achieve a corresponding position on hydrogen transport.

4 THE BELLONA STORY

4.1 Background

In 1986 two members, Frederic Hauge and Rune Haaland, broke out of Nature and Youth (NoU), the youth organisation of The Norwegian society for the conservation of nature (NVF), and founded the Bellona Foundation together with some friends. This was neither an expression of a split with NoU, nor was it their intention to compete with the other organisations, rather the opposite to make a supplement. They wanted an organisation with a different structure, a more mobile, dynamic and efficient organisation which spent much resources to keep professional updated without being delayed by slow internal bureaucracy.

Bellona started in the period of "professionalisation", a notion used to describe a period in the change of environmentally related science and technology policy in Europe. New sorts of expertise, institutions and organisations with interest in environmental and energy issues arose (Jamison 1999:2; Jamison 2001A:10). This also included an ideological shift of science and technology policy, from a societal orientation to more economic emphasis. Thus, the idea of starting such a focused and professional organisation was not new "It has been discussed thousand times over a beer or a cup of coffee. The only difference between these boys and the rest of us, is that they did not go home and sleep off the enthusiasm. Haaland and Hauge went directly to work" (Ambjørnsen 1988:14-15). These young men were without much formal education – Hauge dropped out of school, and Haaland worked as a schoolteacher and did for some time support Hauge (Dekker *et al*. 1998:71). About these men Ambjørnsen writes: "Many times I have thought that we shall be very happy that guys as Hauge and Haaland do not decide to start producing shirts or to play on the stock exchange. They would with great certainty succeed in that also" (Ambjørnsen 1988:15).

Bellona wanted to be able to help local environmental groups on the grassroots level with advice, facts and assistance to combat powerful bureaucrats and industrial companies. In addition, they wanted an organisation that did avoid using unconventional methods and direct action. Greenpeace that had operated for several years at that time and had grown relatively big in many countries did never really make it in Norway. It seems that Bellona started out a bit like Greenpeace, and initially came to fill that space or role Greenpeace did in other countries. Ambjørnsen puts it this way: “I probably don't say anything wrong by indicating that the Bellona-people in the starting phase have received inspiration from an organisation like Greenpeace.” (Ambjørnsen1988:14).

In the 1980s Bellona became first of all known for their actions against firms they meant committed environmental crime on the local level. Later they have become more international, especially through their work with nuclear pollution in Russia, and more oriented on collecting facts and perform analysis. Now they discuss with industrial managers as well as with cabinet ministers. “Now we often get through without turning to direct actions. However, this does not mean that we have sent the old chains to re-circulation!” Bellona says (Bellona’s web-site 04.10.00).

An organisation is formed by the context it operates in. The “national policy or governance style”, as well as the “national mentalities” will influence the national environmentalism – the “national shade of green” (Jamison 2001B:100). For example:

> Countries with strong “populist” traditions such as Denmark and the United States provide substantial power to local authorities and comparatively open access to decision-making, while other countries with stronger statist orientations, such as Sweden, France and China, tend

> towards less directly accessible and more centralised forms of governance. (Jamison 2001B:100).

Jamison has also found that in countries with bipolar political party systems, such as Britain and the United States, environmental politics has been channelled more effectively into NGOs. While countries with multiparty systems, such as Denmark and Germany, often with broad political representation have a more consensual approach to decision-making. As well differences in geographical conditions, like the access to large wilderness areas or dense population, influence people's approach to environmental knowledge and politics. (Jamison 2001B:100-101).

Regarding the Nordic countries it is shown that the Danish environmental movement is rather decentralised, consensual and corporative based, and has had a rather strong influence on the national environmental policy. Sweden entered the arena earlier, however, here the structure is more centralised and the environmental expressions are ‘harder’ and more action like (Jamison *et al.* 1990). In Norway the environmental organisation are to a greater degree than in Sweden invited into the political and governmental processes.

The Norwegian context’s main traits have been characterised as “state friendliness” and “local society perspective” (Bortne *et al.* 2001). There is a relatively close interaction between environmental organisations and the state. Environmental issues are incorporated into the state policy relatively quickly, and in general the environmentalists have higher trust in the state, compared to environmentalists in many other countries. This might also be the reason that no green political party has grown big in Norway. In addition, Norwegian nature and the Norwegian local society have had a dominant role in the history, also prior to the environmental movement, giving the local society some sort of power, a legitimacy that have influenced the Norwegian environmental movement.

> In Norway there is a tendency to, when it comes to environmentalism and nature, to think human society, local society, together with the nature. Protection is about humans at work, in close contact with wild nature. This is an extremely non-urban background, that the foreigners have difficulty to understand (Kvaløy Setreng 1996:110).

The Norwegian environmental movement consists of a range of different organisation, usually identified by 12 organisations[13], which are giving a picture of an environmental movement with organisations that complement each other rather well. There is some sort of a division of labour between the different organisations in the Norwegian environmental movement. It is rare that situations arise where environmental organisations directly challenge each other, Bellona says (Hotvedt 22.05.01). The variations cover what they work for and the way they work. There are organisations focusing on items like: classical environmental protection, establishment of national parks and landscape protection areas, wild life, animals rights, agriculture, pollution, global or local, international or national, the third world, etc.

However, there sometimes occur situations with some sort of competition between the Norwegian environmental organisations, for example for the attention in the media, and in situations when they want to apply for limited public funds. In addition, they can sometimes disagree in specific cases like in the discussion about waste, where Bellona believes that it is possible to carry through source sorting and energy production from the exceeding waste products. Other organisations argue that the burning will be at the expense of the source sorting, believe that it is not possible to combine the two.

[13] In several reports, for example (Reppen 1997), the following organisations are included in the Norwegian environmental movement: NOHA, Norsk Økologisk Landbrukslag, Greenpeace, Natur og Ungdom, Den Norske Turistorening, WWF, Bellona, Kvinner og Miljø, Framtiden i våre hender, Norges Miljøvernforbund, Miljøheimevernet, Norges Naturvernforbund.

4.2 Objectives and beliefs

Bellon's main focus is on pollution, and it describes itself as "a science based environmental organisation whose main objective is to combat problems of environmental degradation, pollution-induced dangers to human health and the ecological impacts of economic development strategies" (Bellona's web-site). They engage themselves to a very small degree in classical animal protection and classical nature protection, - such as nature parks and protection of particular areas, plants and species against encroachment or construction work in the nature. It has occurred and will probably occur again that Bellona in given situations will engage itself in that type of cases. But that will usually be in co-operation with other organisations that have this as its special field. Like WWF (World wildlife found), which is much into biological protection, and NVF, which usually has worked more for the landscape protection. However, both organisations have lately also worked with pollution cases. Thus, once in a while the organisations are touching each other's main areas. However, by and large Bellona works with industrial destruction of the environment through pollution and poisoning, including radioactivity, – pollution as a result of human influence. Due to its limited resources Bellona has to give priority to certain cases. At present its selected main cases are: waste, environmental crime and the role of the authorities, Russia and nuclear storage, and energy with its sustainable solution – hydrogen (Bellona 13-14.06.01).

Bellona has, like most of the Norwegian environmental organisations, maybe the clearest anthropocentric view on nature. They are putting the human being in the centre. As they say themselves:

> We do not fight for the waters right to be clean. We fight for the human beings right for clean water. It is not like the nature has rights on it own,

> which we sometimes can believe from the arguments we meet in the environmental movement. Human beings have the right to nature, – right to much nature, clean nature, right to not become ill from the food we eat or from the air we breath or from the water we drink. This is one of the basic principles for Bellona's work (Hotvedt 22.05.01).

Environmental knowledge, for Bellona, is not valued for its place in an ecological philosophy, it is valued as instrument and as arguments. "Bellona believe in new technology, and will focus on positive solutions in stead of all the negative. … Actually, we do not need an ideology. What we need is an increased understanding of the ecological connections," said the former administrative director in Bellona, Knut-Erik Nilsen (Nielsen 1996:198).

Bellona believes that society, through a combination of changing people's conduct towards environmental matters and better technological solutions, can maintain its economic development with minor damages to nature. In general, Bellona does not so much challenge the demand or emphasises changes in modern attitude, values, lifestyles etc. Their attitude is that new solutions must be cheaper, better and pollution free.

Since Bellona believes in technological solution, it is often called "technology optimistic". However, they do not want technological development for its own sake, but believe that it is possible to make the 'right' technology if the right conditions, efforts and priorities are made by the right people or actors. Thus they have a selective critical attitude to technology, opposing certain applications. In addition, Bellona does not necessarily see any contradiction in being environmental friendly and being competitive and economic. It can rather give competitive advantages or become a business. Regarding hydrogen production in Norway they say:

> Hydrogen produced without emission or discharge to the environment can become an extensive export article for Norway, and represent processing of our nature resources. It is important that the country does not let this opportunity go. Bellona wants the authorities to make a long-term R&D-program for hydrogen, like many other countries have done (Kruse & Hustad 2001:23).

Bellona accepts the United Nation climate panel's statement saying that the majority of the gathered evidence indicates a significant human created affect on the global climate, and focuses on the close relation between activities in the energy area and the problems of global heating and the greenhouse effect. They act according to the "precaution principle", they do not wait until they are completely sure that something is harmful before they start to act, - a justifiable suspicion is enough. Because if we wait until we are 100% sure, they say, then the damage has often happened and it might be irreparable (Hotvedt 21.0501).

The consumers are Bellona's main focus in the sense that Bellona looks at itself as an advocate for the consumers' or public's interests – especially in a long term perspective. As they say themselves Bellona thinks-, takes conflicts-, co-operates- and finds solutions for the future. Regarding the work against pollution in Norway, Bellona takes its starting point from the §110b in the Norwegian constitution. Bellona interprets this law as the state shall prevent damage to humans and nature. Bellona defences this right, and says, "visions without action become illusions, and having knowledge obliges" (Palm 14.06.01).

4.3 Organisation

Bellona is organised by a board, which is elected by the founders and the employees, and with two leaders. The main leader of Bellona is one of the founders, Frederic Hauge. In addition, there is an administrative director, Siri Engesæth.

Most of their work Bellona executes in Norway, but they have as well performed extensive work in Russia, where they now have two offices – one in Murmansk and one in St. Petersburg. In addition, they have offices in the EU (Brussels) and in the USA (Washington DC). These two offices have just been listening posts and lobby offices.

In Norway Bellona has about 30 permanent employees and a few persons engaged in connection with specific projects. In addition, Bellona is authorised to employ men doing their alternative to military service[14], the exact number of those varies from week to week, but are now 12-13 persons. All together there are app. 45 persons, producing about 40 man-labour year. Internationally they have 15 persons: 5 in Murmansk, 7 in St. Petersburg, 2 in Washington DC and 1 in Brussels.

Bellona is organised according to their so-called B7 strategy. This long term working strategy was put into action in 1998. The B1 to B7 indicate Bellona's preferential areas, and the various reference-groups or programs where firms can co-operate with Bellona. So far 32 companies have engaged in a framework agreement of three year. Among them are companies like Phillips Petroleum, Statoil, SAS and Aker Maritime.

[14] "sivilarbeidere". Due to compulsory military service there is some conscience objectors.

In 2000 Bellona's income was 21,5 mill NoK. The main income comes from private firms through advertising and the B7-partners[15]. And the support-members (app. 3500 persons), contribute with about 1 mill NoK per year. In addition, they receive gifts and have some income from various sales. Bellona is not recognised as a democratic organisation, and therefor does not get any general governmental support, however, last years Bellona has received money from the Ministry of Foreign Affairs in Norway to some specific projects they have ran in Russia. Because of the heavily resource requiring Nikitin case[16] Bellona has had some very tight years. However, in 2000 the Foundation again had some surplus, and now Bellona has modest capital assets (Engesæth 13.06.01).

In contrast to other organisations that base their work on the members' direct engagement, Bellona is a non-democratic foundation, without ordinary members, just support-members. This implies that the members are less important in the daily work. But they are important as a barometer in the public, a confirmation that we do something right, they say (Hotvedt 22.05.01). In addition, even though it currently constitutes a minor part of the total budget, this relatively stable and firm group of support-member, are seen as some sort of an economic guarantor.

Most of the professional staff has higher education, and most of the employees have working experience. Many have hybrid backgrounds, for example one has studied chemistry and law and another has studied anthropology and engineering. Others are specialised in different subjects, like atom-physics or law, or have a background in different environment related studies and professions. There is a tendency that the people who have worked the longest period for Bellona are less formal educated. They have their background in the

[15] 7,6 mill NoK from B7-partners in 2000 (Nordby 14.06.01).
[16] The Russian Bellona worker Alexandr Nikitin was charged by Russian security police FSB (former KGB) for espionage, through his work on the report about the North fleet. He was first arrested in 1996 and the final victory he gained in 2001.

environmental movement. Their contribution is more related to their tacit knowledge achieved through activist experience and practical environmental related work. The age of the Bellona workers vary a lot, however the typical Bellona-worker is a man in his early 30s. One reason for the high number of male staff is that Bellona has many relatively well educated doing their alternative to military service who want to work for Bellona, to be able to utilise their own competence during their duty. They act as a natural resource of recruitment. With respect to recruitment, many are recruited through the environmental movement, especially from NoU. In addition, Bellona also advertises for people with particular skills, besides using their network, and hook on to interesting people they meet or hear about.

Bellona's core competence are within these areas:

- Energy technique: traditional nuclear physics, fossil fuel, and classical alternative energy to modern fuel-cell technology.
- Law: environmental advising, the Norwegian "law of pollution"
- Environmental management and administration: biology, chemistry, transport communication, agriculture etc.

Bellona aims at, and is known for, a high professional level in law. Notifying the police and following up cases according to the "law of pollution" and other relevant parts of the law is Bellona seeing as one of the best sanctions options they have beside more action related sanctions. In addition, utilising the "law of pollution" Bellona sees as very important when it comes to achieving results.

The dissemination of knowledge is mainly performed through Bellona's printed publications, like fact-sheet, reports and working memos. Its employees are also giving lectures, attending conferences and congresses or participating in debates in different media and in different sort of forums. Bellona is active in discussions, and in particular cases often referred to[17].

[17] For example cases about melting-works, and the ongoing case about mining on Svalbard.

Through different forums and media knowledge reaches different people. One of their main communication channels is their web-site on the internet. In relation to the Kursk accident[18] it had 5 million visitors.

The main characteristics of, or guiding line for, their work or their way of approaching a problem is:

1) Facts: information & data.
2) Pragmatic & realistic.
3) Action.

They very much emphasis on finding and achieving facts. No one should be able to take Bellona for factual faults, and they do not publish facts that are not checked and double-checked, they say. Bellona's front figures often use the word 'facts' extensively. "It is important to know what the facts are to find the solutions… Without facts we can never reach the right goals" and "We want to know and not to go on expense of facts" Hauge (Bellona 13-14.06.01) says. He adds, "the day Bellona loses its integrity no one will support us". Bellona seeks consciously to act as a pragmatic organisation, and work in a professional, specialist and "scientific" style.

The cases Bellona run, are usually identified by the program-groups, and brought up on a weekly B7 meeting, where it is evaluated to see if it is something to give priority. The selection of cases are made by considering:

- Importance? – The principal or political importance of the case.
- Capacity? – Bellona's competence, knowledge and resources.
- Acuteness? – Acute danger for life and health.

When Bellona is going for a case they use the media as much as they can, but they do not select on the basis of pure media reasons, they say (Hotvedt 21.05.01). Bellona's product is

[18] A Russian nuclear submarine that sank in 2001.

the cases they work on, and getting approval for their view and getting their requirements through are seen as their victories. For Bellona it is important to show that fighting is necessary to gain the victory.

Generally all collaborators shall document what they do and file papers and documents. All correspondence, deliberation reports, working memos, reports, hearing reports etc. are filed. Especially when it comes to cases that might have juridical implications the documenting and filing requirements are strict. Like when Bellona files a complaint to the police or risks a counter-complaint when making a blockage or taking action. However, through the B7 collaboration there are situations where they meet without taking notes, making the participants feeling free to say whatever without being afraid of being referred to afterwards. They want to make room for people to get their frustration out without any "risk". In the energy group they mainly work with individual persons, and they prefer small informal meetings, without extensive minutes taken. And so far they have not given documentation priority.

4.4 Hydrogen work

4.4.1 Introduction

Bellona's answer to sustainable energy-systems is hydrogen. And the best way to kick off the development in the right direction, they say, is to develop a sustainable fossil cycles, by decarbonasion of the hydrocarbons like coal and natural gas. However, the aim in long term is to have energy-systems based on new renewable energy sources. But Bellona thinks it is utopian to aim at no use of the hydrocarbon-sources we have. Currently about 80% of the world's energy consumption is based on fossil fuel, and we will have to use the fossil energy

for still some time, they say. Many places in the world there are for instance still lots of coal reserves, like in China, the only energy source they have, except for some limited water power and the option of using nuclear energy, is coal. They will use coal for at least 40 years more, or until an alternative appears. Norway is of course interested in getting what is possible out of its oil and gas resource, which constitute 40% of the European natural-gas reserves, and 75% of the oil reserves in West-Europe or 4% of the worlds oil export.

Bellona argues that we should go directly for the clean technology, not the half clean. To change from diesel or coal to natural gas is not a long-term solution. As one of their employees puts it; “It might give you a quiet conscience now, but after a while that is not enough. We aim at the long term sustainable.” The short-term solutions should not hinder a 0-emmission solution in the future, which going for methanol or natural gas will, Bellona argues. Such intermediate solutions require intermediate or additional infrastructure that will not just take up resources and add expenses to the total technological change, but probably hamper and delay the best solutions, they argue. They do not see the commercial incentives in developing two distinct infrastructures, methanol and hydrogen in Norway. Bellona refers to Shell Hydrogen which concludes “do it once and do it right” for economic reasons (Palm 14.06.01). As well will complexity and price usually increase and efficiency decrease by use of hybrid solutions. Bellona rather wants Norway to wait some years on the technical development, and if necessary, in the meantime, import electricity from Danish coal-power plants, to get the best initially solution, than start on building an intermediate solution right away.

The basis for Bellona’s hydrogen work is the objective of using the natural-gas resources in Norway. As an environmental organisation it is rather unusual to agree upon the use of Norway’s natural-gas resources. But Bellona focuses on the way to utilise it. The gas should be decarbonised, and the CO_2 deposited to get the environmental lifecycle calculation to go

up. Hydrogen fits very well into the Norwegian energy-system, they argue. It is not just because of Norway's oil and natural-gas reserves, but also due to its storage capacity of the European production of CO_2. Norway has the main solution for much of the energy-related pollution in northern Europe, Bellona argues. In addition, CO_2 used for pressure support will increase the natural-gas production for sale. To day Norway uses about half of the gas taken up as pressure support in the oil field. Why should we then build new natural-gas fields? As well, is it estimated that CO_2 used as pressure support might increase the lifetime of some oil fields (Hustad 11.10.01).

Bellona argues that Norway should compete with Iceland about becoming the first "hydrogen society" or "economy". Norway has natural conditions that no other country has, and competence and experience. In addition, investments in hydrogen will contribute to secure the Norwegian resources, give an export potential and a competitive edge, and will most likely create new places of work. "The best way to foresee the future is to create it" (Palm 14.06.01).

4.4.2 Bellona's Hydrogen program

Bellona aim at ensuring that national decisions in matters like fuel choice, infrastructure development, etc, take into account long-term environmental goals promoting a sustainable approach to the complete energy chain from well-head to end-user. At the same time, they say, they are well aware of the importance of ensuring that Norwegian industry remains competitive. In their search for constructive solutions one long-term strategy is to work for the introduction of hydrogen in conjunction with demands in the industry, transportation and niche areas of the power generation sector. Bellona believes that the hydrogen market is about to open up, and they want to show this to all relevant parties.

Their initial concrete goals are that 5% of the energy consumption in Europe in 2010 should come from hydrogen, and 10 % in 2015. This includes the use for industrial purposes. On the way, an objective is to have initiated 800 mill NoK spent by various actors in 2005-06 on hydrogen activities in Norway.

Bellona has recently made a strategy, about what they call “Bellona hydrogen project”, which they are about to develop further. The time-span for the strategy reaches from 1997 to 2010. They have identified the following four phases for their work:

Phase 0: “Searching for the solutions” 1997-2001

Phase 1: “Road maps to the Hy-Way” 2001-2004

Phase 2: “From talking to walking the Hy-Way” 2004-2007

Phase 3: “Driving the Hy-Way” 2007-2010

The first phase, phase 0 has been performed, and they are about to enter phase 1 where they aim at making roadmaps to avoid “dead ends” – roads that do not lead all the way to the desired goal.

Bellona believes that Norway can not be seen independently from other countries. In this project they especially focus on the three regions Norway, the North Sea and Europe or more specific the EU – towards political and technical network through their office in Brussels. Bellona also wants to introduce hydrogen in Russia. Russia has a very ramshackle hydrocarbon-infrastructure, and Bellona thinks hydrogen can play an important role in the new upgraded infrastructure. To use CO_2 as a pressure support for oil production vast amounts is needed. In this respect, initially, Denmark is seen as an important partner.

At present 7 persons are involved in the hydrogen project for Bellona in one way or another, constituting a workload of about 3 men. The manning and organisational matters for this project are still under development. However, the current two most central persons are one

that has a sort of manager position and has the responsibility to develop Bellona's hydrogen strategy, in addition to run his own firm, CO_2-Norway. While a man with long and extensive experience from the industry, who left Norsk Hydro in a re-organisation operation, has recently got the responsible for the co-ordination of Bellona's hydrogen project.

The planned budget is 7,8 mill NoK per year. At present they have got some money from the Norwegian transport ministry, but lacks most of it. However, due to much positive response they believe they will get hold of what they need.

The required work they think consists of 15% technical-, 35% financial- and 50% dialogue- and motivation related work. As to dialogue and motivation they are not participating in established networks. They just make their own network, aiming at knowing the key persons. They already know about 80 % of the people in Norway that are worth knowing, they say. Their experience is that more usually happens after 15-minutes talk at an airport with the right person than after a whole day at a conference or at a network meeting.

To be able to influence and get results Bellona thinks it is important to work in different forum, on various arenas with different actors.

The consumers make up an important base for Bellona's activities, and they are working for various demo-projects to reach out to the consumers. In general they promote public and political awareness through information gathering, media coverage, and demonstration projects.

Bellona find it more efficient to work directly with the industry than go via the authorities. Bellona has communicated with the industry the last 4 years on the basis of their experience from the 10 previous years, and feels that they have got an understanding of what the

industry needs. However, Bellona emphasises long-term thinking, and they see that the industry can think and work in an even longer perspective than they do now under the right frame conditions. The incentives, like laws and taxes, influence their way of thinking. Thus, Bellona has to work with the politicians.

Bellona works less through governmental committees etc. They are not patience enough for that. They lobby the politicians, an unconventional type of lobbying, says Trond Nordby (Nordby 14.06.01) and describes Hauge as a "desperado" like type of lobbyist. They perform much direct political lobbying, both in Norway and in Brussels within the EU. Bellona sees the legislation as very important. Hauge is for instance working with the EU to established an European Clean Air Act, inspired by the CAA, - a plan for reducing air pollution, in the USA.

Bellona is also thinking about establishing a hydrogen fund for promoting hydrogen enabling technologies. They think they have many competitive advantages compared to other alternative energy fond. For instance their narrow and profound focus on hydrogen technology, as well as their 10 years of knowledge of hydrogen and their distinctive attitude – You are unconventional but we like that!, is often a reaction they get. The trends in the competing funds are that they have a broad approach and are driven by economists and management rather than based on technology. They usually base their analysis just on strategic documents, through which they do not find the key technologies, Bellona argues. As the first step in their "analysis" Bellona's workers aim at the right people rather than the right business plans. One of the employees puts it something like this: "It is during a lunch we get to know the important stuff: their thoughts, the problems and the challenges etc. not by reading business plans. We emphasis the right attitudes like honesty and good guidelines". The motivation for establishing this fund is that they want to do something to contribute to a sustainable development they believe in, as well as strengthen their knowledge and capacity,

and become more independent of the industry. But in the end, starting such a fund is a strategic decision.

The most important is to get money into this and to co-ordinate all the arenas. But it is also necessary to educate people further through lobbying and media campaigns. “In this way we shouldn't have to spend too much time explaining to politicians, investors and executive decision-makers exactly why hydrogen has come of age”, Bellona says (Hotvedt 2000).

To some degree, Bellona has parts of oil companies with them. For example Norsk Hydro (Cloed 14.06.01) says that they think it is sad that the Norwegians have to go to Iceland to participate in a hydrogen-project, and just hopes that Sweden and Denmark are not going into this before Norway. However, Statoil for example disagrees with the strategy, they argue (Barland 13.06.01) that we “should at all time utilise the best technology present”, thus, going for methanol is the ‘Statoil solution’.

In the next chapter Bellona’s interaction with other actors – its role of mediation between actors – is further analysed, as well as its knowledge mediation.

5 ANALYSIS[19]

5.1 Mediating knowledge

Through most of Bellona's hydrogen work they are directly or indirectly performing knowledge mediation. They are collecting and processing knowledge, interpreting it, combining it in new ways or translating it into new contexts or "languages".

The employees and the way Bellona is organised constitute a tool in the process of knowledge mediation. Bellona is an organisation where persons have the possibility to fulfil and realise their visions. Persons with initiative, ideas and the vision of doing something for the environment, the future, the people etc. that comply with Bellona's objectives can here get room, directly and indirectly, to perform it. The organisation is rather flat and the workers have a great degree of control and influence over their own job. On the input side, they to some degree attract or mobilise resources that it might be difficult to make the most of in other more institutionalised organisational forms. On the output side, they generate new "types" of professionals or "movement intellectuals" that can carry the organisations approach, attitude and thinking into the larger society when they end their employment.

Sometimes Bellona acts as *catalysts*. Catalyst can be defined thus: "substance that speeds up a chemical reaction without itself changing" and "personal thing that causes a change" (Hornby 1989). Bellona brings the development a step forward by indicating new ideas and possibilities, translating and transferring knowledge.

[19] This chapter is mainly based on information gathered through interviews, conferences and meetings.

They express concrete thoughts and suggestions that are developed further by others. This is how they will aim at making the 8 mill NoK they plan to spend themselves on hydrogen work each year to become 800 mill NoK spent on hydrogen related activities in Norway in year 2005-06.

Bellona wants to be unconventional, creative and different in the way they think and work. In their formulation of alternative solutions they emphasise combining different sort of knowledge in new ways. For example Bellona played a role in the process of seeing the possibility of the so-called "CO_2-free" gas power plants. They investigated technological solution broadly and noticed that much of the required technology, was used other places in other context. By this they contributed to the process of opening the industries eyes for the option of working for such a solution.

Bellona has ambitious goals on behalf of itself and the society. They aim at radical changes in the Norwegian energy-system. They want Norway to be a forerunner into the "hydrogen society", and aim for making the hydrogen-society before others think it will be released. Through this work, they contribute to and facilitate production of radical new knowledge. One can say that Bellona applies double-loop-learning, because they rather aim at totally new or major changes in systems or technology, than adjustments to the existing. The latter is so-called end-of-pipe solutions, which often correspond to single-loop-learning.

Sometimes they are criticised by the industry for running too fast, talking about possibilities that are not ready – being unrealistic. Also, prior to the change in the Danish energy-systems there were actors accused of being unrealistic:

> it is also an interesting lesson from the energy sector the last 25 years, that a politic that is due to a row of grassroots organisations and a row of foresighted single persons' effort, which at that time in the 1970s was

> pointed out to be irresponsible, naive, exotic and without perception of the reality's real economic values, was the base for a technological development, which in addition to its positive environmental effects also secured establishment of the most successful export sector in Denmark in that period (Hvelplund & Lund 2001:194).

In Bellona's case they experience that when times passes much of their arguments are coming back to them, which they think is good – it is a way of working. Indeed in the period from Bellona started working with hydrogen in 1997, there has been an increase in the interest and activities around hydrogen related issues. Thus, it seems like it is not too early to make hydrogen an issue – to bring it into the arenas of discussion, as well as into the battles to be recognised as technical realisable, significant and economic.

Bellona does not say that they have the exact solutions for everything, but they want to contribute to a certain way of thinking and to start certain debates. They want to contribute with ideas and examples of possible solutions, by for example contrasting the size of numbers – like showing that 3 months of the CO_2 tax on fuel[20] will cover the building of a pollution free initial infrastructure in the south of Norway. And 2 more weeks will finance all the demo-projects planned in Norway. Thus they suggest using 10% of the CO_2 tax on fuel which is 7øre per litre gasoline (in comparison, the first reduction in the gasoline tax in 2001 was 120øre per litre) to build infrastructure and get domo-project and more R&D started. They also emphasise the principle that the effect of the emission should be included in the energy and technology prices, especially for the local pollution – to increase people's awareness and knowledge.

[20] 70øre per litre gasoline and 50øre per litre diesel.

5.2 Mediating between actors

Bellona sees itself as having a unique position among the different actors, - a dynamic role or the ability to move into different arenas, environments or positions. One day they work on the political arena, the other day the technical, financial or the public. Not just by attending different arenas themselves they contribute to connect those “worlds”, but also through their work where they bring actors from different fields or sectors together.

Bellona is facilitating spaces or gatherings, where individual autonomy and the relevance of different truths held by different groups are accepted. However, it is not enough just to make people meet or talk. Negotiations and education within the group or network about what are key features of the co-operation also need to be brought to some kind of closure. To get results following up and commitments are of great importance. There are many examples of good intentions and exchange of nice ideas which end in a desk drawer, because no one really has the interest or takes the responsibility of closing the matter. Bellona goes for results, it is result- and action oriented, and relatively impatient. In addition, they are evaluated for their achievements on environmental cases, thus, they have incentives to follow-up and close cases.

Regarding the hydrogen work at the government-industrial interface, Bellona is currently working mostly in the governmental domain. Based on their understanding of what sort of political measures that the industry needs for bringing about the type of technical change Bellona wants, they lobby, hold presentations and arrange conferences. The politicians are also asking for Bellona's knowledge. For example, during meetings the author had with

Bellona, they were calling from OED (The Norwegian ministry of oil and energy)[21] and the Prime Minister's office[22] to ask for information. And now Thomas Palm, responsible for the energy-work in Bellona, has been engaged by OED to work with the plans for low-emission gas power plants (Kaarbø 21.11.01). As well Engesæth has a seat in a committee that shall look at potential areas for using the Norwegian natural gas[23]. In given cases Bellona uses their web-site strategically towards specific politicians. Bellona does not just impart the requirements from the industry directly to the politicians, they connect them with their own environmental objectives and transform them into matters of a sustainable energy-system.

Bellona – in accordance with the industry's request for more stable frame conditions and predictable future with respect to legislation and requirements from the authorities – aims at influencing the 'right' political measures. The political measures seem just to be taxes and duties, which Bellona argues are usually more restraining than promoting changes. In spite of this Bellona is often blamed for the taxes, which Hauge says he is fed up about. In addition, he is fed up about the politicians and authorities that are more focused on punishment than awards. "The politicians have not understood anything of what the industry needs" he argues, and "they lack visions" (Hauge 14.06.01). They are short-term thinkers, usually much shorter than people from the industry and from finance. Hauge argue that the CAA has meant more than all the CO_2 taxes together. It has given the Californian industry 14 years of predictability, he says. In Norway the tax is changed with a few months notice!

Bellona wants the politicians to be more visionary, to have goals and strategies to utilise Norway's expertise and resources and push the industrial development in the wanted direction, towards a pollution free energy-system. Norway should have a long-term strategy on how to approach the "hydrogen society". Instead of crying about special condition for

[21] Meeting with Hustad 11.10.01.
[22] Meeting with Hauge 31.10.01.
[23] The governmental Gas-power committee, "Gasskraft utvalget".

Norwegian raw materials, like prices, subsidises etc. in European co-operations they should develop the technology for tomorrow. Then, we will be interesting, Bellona argues, a forerunner Europe cannot overlook (Engesæth 18.10.01). Norway, with its wealth and resources, should be a leader and an initiator with respect to developing new and better technologies and performing technical change in our society. There are not many other countries having the same incentives and opportunities of being a pioneer, Bellona argues. Norway has loads of money and a bad conscience because of the "petroholism". And Bellona feels they have good support for this argument within the industry. They are emphasising to politicians that it should be the role of the government to initiate investments in both a CO_2- and a hydrogen-infrastructure.

Bellona often seems rather dissatisfied with the effort from the politicians and the authorities. They should have a much broader view and contribute more to constructive long-term solutions, Bellona argues. "The bureaucrats in SFT [the state's pollution inspection] and the environmental department do not know anything… those in the industry that know what is needed ….", Hauge says. He bases this on the experience from Bellona's engagement in the group that worked on the "CO_2-free" gas-power plants, where SFT chose not to participate. "SFT arrived on the first meeting and said this will not give any pollution and never showed up again", (Hauge 14.06.01) . Hauge has weekly contact with people in the government. Sometimes Bellona feels they are giving Norwegian politicians basic education.

In a political debate about the emission challenge and hydrogen as a solution under a conference June 2001 (conference 2), some politicians admitted that they knew very little about hydrogen, and asked Bellona to talk more to them like they do with the industry. In addition, it was pointed out that the Bellona reports are important, and that Bellona had changed from a pressure group into a premise supplier. In a speech from the authorities it was pointed out that the authorities are positive to the way Bellona works,- they want a

relation to Bellona. But they do not agree with Bellona in everything. However, they shall not become alike, but they want a constructive co-operation. This seemed to be not just nice words in relation to Bellona's 15th anniversary, because some months later Bellona was invited to give a presentation for politicians and people from the ministries. The authorities have also appreciated Bellona's contacts in Russia. They want to use Bellona's work and contacts in Russia as a tool to get foreign resources and pressure into Russia. They see this as a possibility to achieve more openness in certain relations with Russia, - and they see it as a value in itself to achieve more openness. (Eide 13.06.01).

Bellona is more interested in speaking to assumed opponents, than slapping the back of those who share theirs views. They appreciate the culture they meet in Russia, where people can quarrel and argue without being enemies, – a culture they do not find in Norway. Norwegians turn very easily personal, Bellona argues (Hauge 13.06.01). They want a constructive dialogue in areas where opinions differ. Through the B7 program with the industry they aim at gathering different actors with different views around their round-table for fruitful discussions. They have succeeded in getting previous 'enemies' like Norsk Hydro and Eramet (former Elkem) on their B7 team. However, this does not imply that the B7 partners avoid Bellona's judgements and attacks[24]. The B7 collaboration takes place according to the consensus principle, where several firms and organisations together work to agree upon what the problems are and how to solve them. Bellona is playing a mediator role through this program – the program can be seen as a mediator strategy.

The program is not based on Bellona doing some sort of consultant service, as if they are advisors, looking at problems someone asks them to, they argue. Bellona wants to secure their economy with 'no strings attached'. The B7 co-operation is a general agreement, not

[24] For example did Bellona notify Hydro U&P Norge to the police for infringement of the law of pollution 08.11.01.

specific projects or tasks. Bellona wants to be able to define their own projects. They might correspond to what the partners want, but Bellona wants to be free to do and define the projects its own way, and not do anything on instruction from other actors. It wants to be its own principal. For example when Bellona held presentation for Hydro about hydrogen they were just giving information, it was not anything Hydro had ordered or any work Bellona had performed for them. Bellona has its own economy for such work. But of course in general they depend on the industry having trust in Bellona. That makes them rather vulnerable, a small mistake, a negative press etc. can lead to economic problems.

The partners appreciate Bellona's constructive and critical attitude, like their counter-expertise role. Thus, some of the B7 participants use Bellona as sparring partner when they are revising, starting or testing new projects or strategies etc. Very often Bellona acts as catalysts, through indicating new ideas or possibilities in the process of environmental friendly technical change. They help firms to see their possibilities in another light, in the technical change of tomorrow. With their constructive approach to technology, which type of technology to develop or how to implement or use it, they contribute to avoid the dichotomy: for vs. against technology in general. Their resistance to specific technical solutions and their social- and environmental aspects will not easily be viewed as technophobia, but rather as a signal to pick up and as an opportunity to optimise the change or achieve a better fit in the society.

Through their work building their own hydrogen technology network they are mediating connection between parties in the industrial domain and facilitating transfer of knowledge. They aim to map who is where in the hydrogen technology development, who needs what, where are the bottlenecks and so on. Then they connect relevant people. They try to place the person with the right competence high up in the organisation in the firms that could gain

from this competence. They try to get these persons into the board or where the actual power is – where the decisions are made – to have real influence.

Bellona has found out that the most important and interesting work regarding hydrogen technology is going on in the small and newer businesses. They see the hydrogen work performed in the big companies being more about nursing their PR image. This complies with Hvelplund and Lund's experience from the introduction of wind-turbines in Denmark saying “major (radical) technological shifts do not derive from old organisations” (Hvelplund & Lund 2001:211). Often the big companies do not have the same incentives. New solutions might contradict the dominant and traditional industrial interests, leaving these actors without initiatives to propel the change. They might already have market share that will be expelled by new technology, and do not have real motivation for driving the development. Bellona has also found that the small companies more often struggle with the finances, and Bellona might establish a hydrogen fund. They have started mediating hydrogen knowledge to financial actors to make them interested in investing in hydrogen technology.

Bellona aims to secure that the main technical solutions or changes the technical experts, which we usually find within the industry and R&D institutions, plan are good for the consumer in a long-term and in a broad perspective. Bellona executes its own type of Constructive Technology Assessment (CTA). CTA is a model for adapting a particular technology to society or to the user, by some criteria through out the technology development process with a special focus on the early phase, the design phase (Schot 2001; Schout 1998). Bellona’s contribution is similar to CTA in that sense that they are influencing the technical change all the way from the beginning of the process. But Bellona is not that much into the detail shaping of a particular technology. It is more advocating on behalf of the consumer at a “higher” level, at the policy level or the intermediate level. They are rather influencing for the right technical trajectories, for what type of technology to develop, than the

design of a specific artefact. They mainly advocate the consumer with respect to the environmental or, more specific the pollution aspect of the technology. For example do they work for and emphasise environmental friendly technology in relation to gas-power plant not the working environment or ergonomic for the potential employees etc.

The mediation or appropriation attempts that are performed in the companies where technological development is carried out, are usually performed by salesmen and marketers or project managers with another starting point than the users and the public. They have to a great degree another agenda, objectives and focus than Bellona. In one of his CTA articles Schot says: “Designers rarely anticipate social effects; they even have a hard enough time anticipating market conditions, and even when they do they do not seem to be in position to put it to good use.” (Schot 1998:214) Thus, he discusses a model to include the users in the technical design and development process.

On the interface between the public and the experts Bellona does not mediate many contacts or connections, for example like OVE did through facilitating public meetings or like the direct interaction CTA is highlighting. However, they give the science and technology of hydrogen a more public understandable or suitable presentation, and relate it to social, environmental and consumer matters. In addition, they influence the process of technical change by working directly with the experts and translating demands into technical requirements. For example they make environmental related requirements for cars as well as for the whole energy-system. Often they act as counter experts, and present knowledge that goes against the institutionalised experts. For example they are arguing against Statoil that wants to utilise methanol as a hydrogen carrier, because Bellona thinks that this does not show us the most economic and environmentally efficient way towards the long-term sustainable solution. They also aim at increasing the publics’ awareness of the choices they have – educating them in

being conscious consumers, without expecting them to use or buy anything just for idealistic purposes.

The current “hydrogen picture” is very complex. Just the hydrogen technology, or rather technologies, contain a complex pattern of (potential) technologies, which are more or less dependent on each other. Through their hydrogen technology network building Bellona aims at mapping this. And in their searching for solutions they look at new ways to combine knowledge and connect or co-ordinate some of the actors accordingly. For example regarding a comprehensive environmental friendly solution for the energy-system in Norway, they aim at connecting and transferring knowledge between offshore and the process industry onshore.

When interdisciplinary work is involved, the process of translating technology policy terms into concrete engineering problems can be particularly complicated. And the needs for cross-profession and cross-field insight are significant. For example does integrated infrastructure of natural-gas, CO_2, hydrogen, electricity requires cross-profession work. In the industry there are usually distinct groups working with electricity, CO_2 etc. Many of Bellona’s employees have a hybrid background. In addition, Bellona is rather unique as an actor in the energy field, in the sense that they focus on all the domains – public, governmental, industrial and to some degree the academic in the sense of its research. Thus, they perform and have much experience in cross-profession or cross-speciality work.

6 CONCLUSION & PERSPECTIVE

In this thesis I have looked at types of mediating roles the Bellona Foundation plays in the process of technical change towards utilisation of hydrogen in the Norwegian energy-system. The analysis is performed by using the concept of mediation. The concept is based on a cultural approach where technical change is seen as a social process, and Bellona is seen as a technical actor. A mediator brings people, actors or domains together on different levels. Besides mediating connection between actors it is, also or to a greater extend, mediating knowledge. The mediator is more or less independent of the other actors, and has social more than economic motives.

Bellona combines the different kinds of mediations in their hydrogen work. Much of their work constitutes knowledge mediation – mainly through interpreting, translating and transferring knowledge, and combining it in new ways. They are performing much mediation within the industry, and hereby also between technical specialists. At the industry-governmental interface they are to a minor degree mediating connection. But they are mediating industrial- and environmental requirements as well as hydrogen related knowledge towards the governmental domain. Currently they perform less direct mediation between the public and the technical experts. However, through their web-site they expose technical knowledge in a popularised form for all interested parties. They also plan to supply more public information and education to prepare the public for the technical change. But they hardly facilitate spaces for experts and the public to meet. They are mediating public demands in a representing way in the sense that they incorporate their interpretations of public demand in their requirements to the experts and the industry. They mostly act on a long-term intermediate policy level concerning technical trajectories, and the close direct contact with the general public seems to be more or less absent.

From this short thesis it is difficult to say how important Bellona's contribution is. We do see that it is a force emphasising environmental sustainable solutions in the process of technical change, based on a long-term, broad, demand and consumer oriented focus. Bellona can be seen as a new actor, from outside the "system of innovation". It takes active interest in and is improving the possibilities for hydrogen. Its mediator role constitutes some sort of a pressure to push the radical technical change of hydrogen into and through political battles. They are mediating to influence the definition of the problems, to get 'hydrogen' into discussions, and to be recognised as technical releasable, significant, and economic.

Understanding of cultural dynamics might help our policy makers. In a way Bellona's mediator role fills an open space in the realm of technology policy making. Their knowledge is in demand and they are used by various actors. Thus, it seems that the role they play in the hydrogen issue is needed. If we are to be able to make socially appropriate and ecologically sustainable technical changes, more and more of the other actors than the established traditional ones should be involved in technical change. The possibilities of public participation should be improved, for example through increased support and encouragement of local initiatives and NGOs, and through providing more opportunities for young people to engage themselves in multidisciplinary studies related to technology and technical change. As well we should strengthening the context for and the process of mediation – more attention to actors of mediation, and in general encourage more interactions.

I have chosen to look at the link between NGO and technical change. There are hardly any comparably studies. Except for some of Jamison's writings, which we already have seen some of, there is not much. However, we can see that the case of knowledge mediation fits with the new knowledge production derived by Gibbons, in relation to environmental

knowledge and the environmental NGO, Bellona. We also see that concepts like mediation and broker make sense – there are actually actors that fill such roles. By and large this study adds a relatively missing actor group into the literature of sociology.

Through the story of Bellona, we get a little glimpse into the big complex world of technology. This thesis shows an example of an NGO's contributions to the process of technical change. It gives deeper insight into the role of mediation, rather than giving a base for generalisation. However, without investigating all the various environmental oriented NGOs we see that different organisations will perform or combine various mediating roles differently. Some work more with the authorities or the politicians, other aim more at influencing the attitude and values of everyone. Many are mediating environmental related knowledge into more or less explicit political requirements. Such requirements might be frame conditions for technical change – shaping the technical change. At a practical and local level an NGO might contribute to the shaping of the technology by the very practical and everyday use and handling of technology. Some sort of knowledge mediation is maybe a typical trait of an NGO, and more or less directly this is shaping the technical changes in society.

Through this work I have seen that an NGO might contribute in many aspects of the process of technical change. The particular matters that I will recommend future work on are the following: In general the NGOs are emphasising matters that arise somewhere in the public and that no traditional actors take care of. They give voice to and advocate views and solutions that the established actors do not (yet) consider. Like how OVE advocated alternative energy-systems and the technical change of wind-turbines for a while until it was included in the established systems. Since radical new ideas or solutions seem to come from outside the establishment, an area for further investigation could be to look at the NGOs role, their contribution to or significance for radical technical changes, especially the initiation of them. Should an NGO be seen as a contributor to radical inventions? Taken into account that

much technology is not appropriate, it does not fit properly into the respective societies and is even causing health and environmental deterioration; it seems that there is a need for a closer interaction. An interaction between the society, the context that the technology is going to work in and influence on, and the technical development process which is most commonly seen to take place in the academic, bureaucratic, and economic domains. There is a need for a better and more even distribution of resources among the various domains. Especially the civic domain lacks resources. Could that be increased through the roles of the NGOs?

ABBREVIATIONS

CO_2	Carbon dioxide
EU	European Union
H_2	Hydrogen gas
NASA	National aeronautics and space administration
NGO	Non-governmental organisation
NoU	Nature and youth (Natur og ungdom)
NVF	the Norwegian society for conservation of nature (Naturvernforbundet)
OVE	Organisation for renewable energy (Organisasjon for vedvarende energi)
PESTO	Public participation and environmental science and technology policy options
R&D	Research and development

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