Work package 2- Historical and recent attitude of stakeholders

Case 22:
ECTOS hydrogen project

M. Maack

July, 2006

*C*ultural Influences on *R*enewable *E*nergy *A*cceptance and *T*ools for the development of communication strategies to promot*E* ACCEPTANCE among key actor groups

Project co-funded by the European Commission within the Sixth Framework Programme (2002-2006)

Contents

Contact

Icelandic New Energy/University of Iceland
María Maack
Borgartuni 37
Reykjavík
101 Iceland

Tel: +354 588 03 17
Fax: +354 588 03 15
Maria.maack@newenergy.is
www.newwenergy.is

1. Introduction

The goal with reporting on the project 'Ecological city Transport System' (ECTOS) from a new angle is to add to our general understanding of societal issues concerning a socio-technical demonstration project (Brown and Vergragt, 2004) - this time in an Icelandic settings. ECTOS will be compared to other cases and an attempt made to find country specific controversy and success factors with respect to social acceptance of new energy technologies. ECTOS was the first introduction of hydrogen technology for transport purposes in Reykjavik (2001-2005). More specifically the study case will focus on communication, dialogue and involvement efforts.

To the reader it may appear as if this case study is glorified whereas there are very few inputs that take up negative remarks, failures and mistakes. But while discussing the subject with the stakeholders the general impression is quite positive and that is what should come across as the main theme of social impacts from the demonstration.

2. Country overview: Iceland, energy and the hydrogen economy

Iceland became an independent republic in 1944. Its economy is highly dependent on fisheries. The country imports its fossil fuels but heat is provided to more than 90% of industrial plants, households and services with heat served by geothermal district heating systems or local hot springs. These also provide steam for process heating or hot water for drying, bathing in outdoor pools, washing and cooking[1]. Industrial plants and households enjoy electricity generated either by hydro or geothermal power. Therefore approximately 70% of the total energy demand in Iceland is produced with renewable energy. The other 30% (mainly oil) is used exclusively for transportation, agricultural vehicles and the fishing fleet. No fossil fuels are to be found and biomass is scarce.

There is a definite political commitment towards further expansion of the use of renewable energy. The white paper of the coalition government (Independence party and Progressive party) states:

> *"Further development of the domestic energy resources is on the Icelandic Government's agenda. The aim is to harness these in order to diversify the economy and lay the foundations for higher living standards and prosperity in the future. One of the possibilities under consideration is the production of alternative fuels such as hydrogen that could replace oil in the transportation sector, i.e. for cars, airplanes and fishing and transport vessels. In addition to diversifying the economy, such use would contribute significantly to reducing the emissions of greenhouse gases[2]."*

In 1994 (Eldsneytisspá) the Icelandic energy authority estimated that in total it would be feasible to generate the amount of 50TWh annually from hydro- and geothermal sources (Ministry of Industry, 1994) but this amount has recently been disputed because of damage to landscape and natural habitats. Since 1998 the government has allocated financial and natural sources to tempt foreign investors, mainly aluminum smelters, offering the untapped hydropower energy as the cleanest and cheapest energy in the world. Geothermal electricity is also offered for the same

[1] More information on the geothermal uses is provided by Reykjavik's Energy. Available online in English at: www.or.is.

[2] 'In the forefront in the new century' Governmental policy statement, in Icelandic and English. The office of the prime minister of Iceland May 28th 1999. The same parties won the elections in 2003 and kept to the same policies.

purposes. The cheapest hydro-power options have already been allocated to these investments but geothermal power stations can compete with them in prices. Until 2005 the geothermal heat has been put to use as well as the electricity generating power thus raising the total energy efficiency from about 17% (efficiency for geothermal electricity power plants to) 80-90% for co-generation plants using both the force from trapped steam and the heat from the condensed medium for heating and industrial purposes.

The governmental policy concerning Kyoto obligations is to meet requirements by reforestation rather than cutting down carbon dioxide emissions. During the first Kyoto episode the Icelandic government negotiated specifically for higher emissions' allowances, claiming that carbon emissions from aluminum smelters that run on renewable energy are much lesser than from those that run on fossil fuels. Also that small economies will suffer from 'out- of proportion' additions to their emissions from large industrial projects but would only add very little to proportional emissions in larger countries. It is currently expected that emissions of CO_2 will have grown by approx. 30% in 2010 compared to 1990. Still the switch from using fossil fuels to geothermal heat had already been implemented before 1985, see Figure 2.1.

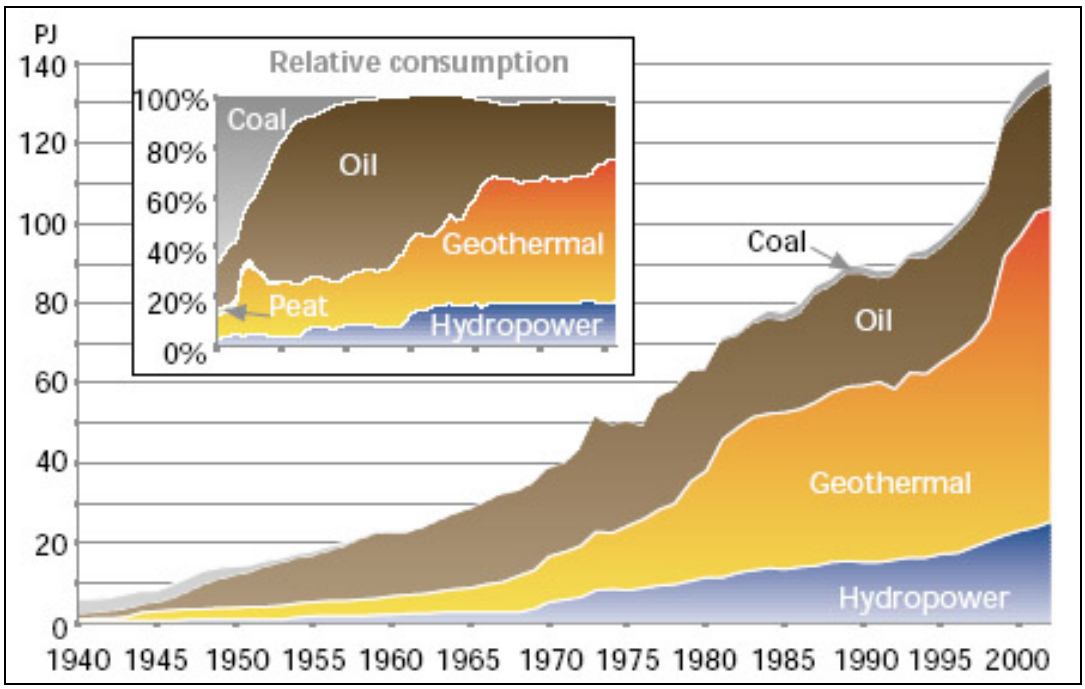

Figure 2.1 *The development of energy use in Iceland between 1940 and 2000. Note the large leaps in the installation of geothermal heat between 1979 and 2000*
Source: the energy authority of Iceland, www.os.is.

At the same time, the total demand for primary energy that would go to produce hydrogen that could cover the fuel demand for the transportation and fishing sectors (excluding cargo ships and flights) in 2030 is estimated to be about 100,000 metric tons of hydrogen. Or as estimated in 2001 to amount to 10% of the available, unexploited national renewable energy sources[3]. Using accepted conversion efficiencies for electrolysis and fuel cells, this amount of hydrogen translates into electricity consumption of approximately 5 TWh. This translates to be about the same

[3] Skulason JB: Vetni eldsneyti framtidarinnar; Orkumenning a Islandi, Orkuthing 2001. Conference proceedings of the national energy summit in Oct 2001, Energy Culture in Iceland. Hydrogen the fuel of the future, Pb: Samorka Iceland http://samorka.is/Apps/WebObjects/Samorka.woa/1/swdocument/1000309/Vetni+-+eldsneyti+framt%C3%AD%C3%B0arinnar+-+J%C3%B3n+Bj%C3%B6rn+Sk%C3%BAlason%2C+N%C3%BDOrka+ehf.pdf.

power which will from 2008 furnace the largest aluminum smelter in the country that is currently under construction[4].

The Hydrogen projects

Hydrogen as an energy carrier has been in public discourse since the 1970s (Maack and Skulason, 2005). Since then, the energy authority of Iceland had supported a working group that produced reports on the feasibility of producing hydrogen locally and using it as a fuel but the main interest lay within the Chemistry department of the University of Iceland, lead by Professor Bragi Arnason[5].

It is foreseen that only electrolysis of water would be the source of hydrogen in Iceland and recent research indicate that electricity and costs can be saved in the future using high heat and high pressure in the process. The technologies of Hydrogen generation and use can easily be integrated with geothermal applications and stand-alone energy systems and come as a natural extension of the energy systems already in place. The ultimate unofficial vision is to cover all local requirements for energy with renewables before 2050.

The hydrogen undertakings, tests, educational outreach and full scale demonstrations have so far mostly been promoted nationally by private companies, institutes and persons. In 2005 an official hydrogen road map was announced but the paper does not serve as a policy paper, rather a list of possible undertakings outside of the governmental sector and has not been published in July 2006[6].

The parliament passed new laws in 2005 lifting import taxes and other charges off equipment that uses hydrogen and other local renewable fuels in transport, but methane is harvested from landfills in Reykjavik and used to run approx. 60 methane cars. A handsome sum of research grant was allocated to the most active researcher within the University of Iceland to facilitate problem solving in the field of hydrogen storage chemistry A consultant to the Icelandic government on hydrogen matters is highly ranked in the International Platform for the Hydrogen Economy and the Icelandic profile is high in international initiatives which are supported (if not financially then) morally by the Government. Still no considerable financial sources have been allocated from national funds for the hydrogen initiatives announced by Icelandic New Energy (see Figure 2.2) Still, no propaganda or policy statements concerning the development of a hydrogen economy has been proclaimed nationally, only a few mentions from speeches in international meetings can be listed.

[4] The aluminium smelter belongs to Alcoa. See further on the homepage of the national power company, Landsvirkjun, www.lv.is/karahnjukar.

[5] Personal communication with ambassador Sigfús Ingimarsson and Professor Bragi Arnason.

[6] Pers communication with Ingolfur Thorbjörnsson, head of environmental department of IceTec, 11th July 2006.

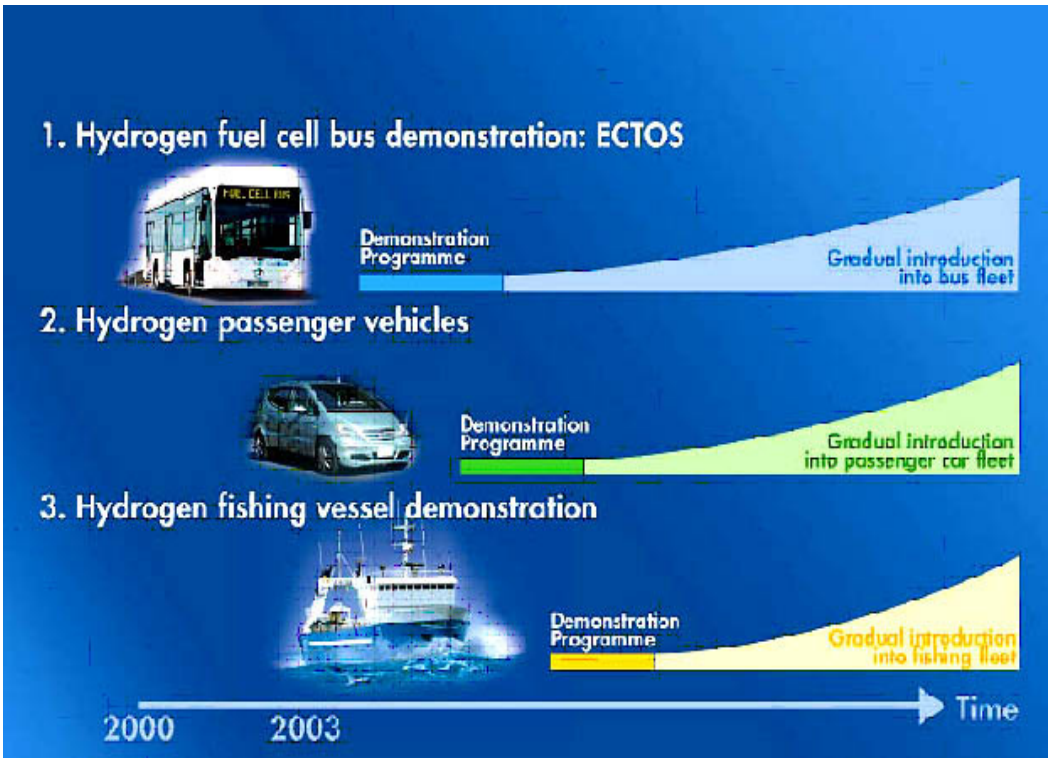

Figure 2.2 *INE's company policy concerning the stepwise introduction of hydrogen into the transportation and fishing sector. The ECTOS project served as step one in the policy*

In 1999 Icelandic New Energy (INE) was founded as a seed company. Three international concerns (Norsk Hydro, Shell Hydrogen and DaimlerChrysler) joined the venture, whose mission became: *"to investigate the potential for eventually replacing the use of fossil fuels in Iceland with hydrogen and create the world's first hydrogen economy"*[7]. Manufacturing is not a part of INE's undertakings, only the dissemination of ideas, management of applied research and demonstration projects, facilitation and integration and problem-solving at the implementation stage. The main task so far, has been to test the use of gaseous hydrogen and fuel cells as the drive train technology within the public transport, to run a hydrogen fuel station and disseminate general information on demand.

3. Summary

ECTOS was a demonstration of newly developed hydrogen and fuel cell transportation system within the public transportation system in Reykjavik. Three pre-commercial fuel cell buses were transported from Germany, an electrolytic hydrogen station made the fuel from water and electricity that was provided by the energy service of the city of Reykjavik. The promotion and coordination was carried out by Icelandic New Energy, Shell Hydrogen and Shell in Iceland saw to the building and running of the hydrogen station, the small retailer of DaimlerChrysler in Iceland provided staff for the maintenance bay of the buses (Ræsir), the public transportation service (Strætó hf) rented the buses and saw to their operation, training of drivers and data sampling. The components of the hydrogen station were provided by NOrsk Hydro that manufactures the electrolysers and the other components of the station as well: compressor, storage cylinders, dispenser and the software that monitors the filling. The media coverage of the project became higher than expected and surveys indicated that the project was well received by the public and raised the expectations of further hydrogenisation of the society.

[7] Further information on the shareholders are to be found on INE's website: www.newenergy.is.

4. Step one: Possible futures

What was the vision in the case study that was produced? (including objectives, time, etc)
The vision of INE were to realize ECTOS as the first step of their hydrogen road map. Goals for ECTOS were stated in the Methodology for the associated socio-enviro-economic research.[8]

The overall goal for ECTOS is to learn:
- How to organise and run a (electrolytic) distribution and infrastructure system to provide hydrogen to vehicles.
- From the execution of the plan and how to implement refinements.
- Which impacts should be expected for a larger [hydrogen energy] system.

ECTOS was in other words organized to become a learning experience that could facilitate the use of hydrogen as a fuel on a large scale, at least within Icelandic conditions. Furthermore it is stated in the goals of the project: *ECTOS is seen as a first step towards further hydrogenisation rather than an isolated technical pilot project.* It was set to test a pre-selected energy path, an extension of the renewable systems and the performance of the state of the art of hydrogen technology.
- The outcome of ECTOS will be used to map drivers and barriers within the implementation of a future hydrogen economy and further political decisions.
- Considerations of the transferability of the studies and outcomes will remain a central issue throughout the study period.

The last note is because a few comments were heard that while using an energy system that are based on only renewables, then the outcomes of the demonstration would not be applicable to pan- European countries. Still the participants claimed afterwards that the learnings were perfectly transferable to other European communities.[9]

5. STEP TWO: What were the various expectations to the case?

ECTOS was initiated in parallel with the foundation of Icelandic New Energy to visualise the paper studies that indicated that Iceland could become self supportive in all energy sectors and base its economy on local renewable energy. This vision is rooted in the Icelandic partnership Vistorka[10] (Eco-Energy, a co-operational platform for the major power companies in Iceland) the consortium that owns Icelandic New Energy - and is not involved in other projects. It implies also that the country may strengthen its political independence, which is considered a central social issue (even in a highly globalized economic network) for a nation of this size[11] that had been submitted to Nordic Kings between 1262 and 1944.

Negotiations with DaimlerChrysler about first demonstrating their fuel cell vehicles (buses) in Reykjavik had already started in 1996. ECTOS was the first step in a strategy for shifting Iceland into the worlds first hydrogen economy[12]. Icelandic New Energy applied for a research grant (€ 2.7 million) to the EC measures connected to environmental policy efforts under the programme Sustainable Development; The city of tomorrow (DG Research). This was granted and the head of the research department became the contact person to the project on behalf of the European Commission, acting as a partner in the project, not only a financial supporter and

[8] María Maack: Reports from ECTOS no 17 Total impact assessment www.newenergy.is/newenergy/upload/files/utgefid_efni/ectos_17-total_impact_assessment_.pdf
[9] See ECTOS deliverable 13 transferability: www.newenergy.is/en/publication/ectos%5Freports/
[10] Vistorka, Eco energy www.newenergy.is/newenergy/upload/files/brochures/vistorka_brochure.pdf
[11] Icelanders were 299.891 31st Dec 2005. www.hagstofa.is (icestatistics).
[12] Minstry for industy and commerce: Towards a sustainable hydrogen economy in Iceland, 2003 uploadable from www.newenergy.is/newenergy/upload/files/brochures/tshe_brochure.pdf

paper-demander. The local expectations were very positive and high and international delegates flocked in showing enthusiasm, interest and co-operational spirit and expectations towards technical innovation for the environment - on a real scale.

Actually the larger EU project, CUTE, emerged only after the formulation and negotiations for the ECTOS with Daimler Benz - now DaimlerChrysler. All along there was more emphasis on public participation and openness within the ECTOS. The spirit was 'implementing hydrogen through public relations'.

Evidence for the public opinion

The launch of ECTOS was first made visible to the public (using local promotional offices) in March 2001; the mayor of Reykjavik hosted the initial announcement ceremonies and the story was followed up in local papers and official news letters. Second major milestone was the inauguration of a hydrogen electrolytic station in April 2003, where reporters from various countries were invited by the shareholders to attend the inauguration of the worlds first pre-commercial hydrogen station and to attend an introductory conference on hydrogen. Third event making the ECTOS more visible for the public was a small welcome ceremony during the shipment of the first 2 hydrogen buses and an 'open day' for the public during their first week in traffic. This was in October 2003 and the demonstration period ended in August 2005. Since then the Icelandic public has seen several international documentaries and news flashes about the Icelandic hydrogen projects. Also school groups have visited the station, presentations have been made to numerous clubs and interest groups on request.

Concurrently major energy issues were debated in the Icelandic society, public disputes were lively on the effects of climate change, energy security, oil prices, energy contracts with foreign investors and governmental support for the invasion in Iraq. The whole period made grounds for an unusually lively energy discourse in all sectors of the society and therefore the hydrogen tests became in a sense the realisation for new, innovative, clean, local and peaceful solution in an energy - worried world.

In 2001 a public telephone survey was carried out before the test drives started[13]. The general acceptance of a hydrogen fuel system was seen as a positive development by 92% of the respondents. This attitude was repeated in a second survey made on the buses and in the streets of Reykjavik in 2004[14]. The communication process was therefore changed during the project from an active 'propaganda approach' to a more passive 'information available for those showing active interest'. The most frequent reasons for positive attitudes were clean technology, environmental benefits and independence from oil imports. No fear or public insecurity was reported during the test periods.

[13] Institute of Applied social Sciences, University of Iceland: Afstaða Íslendinga til vetnis, Dec 2001; public attitude towards hydrogen, coordinator: Aevar Þórólfsson, Jan 2002.

[14] ECTOS deliverable 12: Social Acceptance - and for comparison to acceptance studies in ECTOS deliverable 17: Total impact assessment. www.newenergy.is/en/publication/ectos%5Freports/

Actor	Expectations	How do they present their effort in terms of public benefits
Icelandic New Energy	Becoming a leading consultancy and the promoter for hydrogen pulling the public towards an Icelandic hydrogen economy	Save imports of oil, make Icelanders independent of fossil fuels by 2050, creating new jobs and refer to a clean national image
Vistorka	ECTOS as a first step in a series of undertakings introducing new energy technologies	The national energy platform should be promoted jointly and more internationally; export of expertise in new energy applications
DaimlerChrysler and EvoBus	To learn more than test in laboratories can give and introduce new high tech environmentally important technology	Researching into mobility with a future - goal: decreasing environmental externalities
European Commission	To secure energy and prevent climate change	To evade health risks but also raise competitiveness within the EU industry
Shell Hydrogen	To gain actual experience from operating the first Shell branded hydrogen infrastructure for gaseous hydrogen	To show commitment to decrease greenhouse gas emissions - (still Shell Hydrogen sold their share in the station during the test period)
Skeljungur in Iceland (Shell Iceland)	Initially to show a park with new renewable technology and become visible as a leader in introducing future technologies	Iceland as a model for a hydrogen future, drawing international attention to Iceland and the hydrogen tests
Norsk Hydro Electrolysers	Become visible and eventual leading in electrolytic equipment for the hydrogen energy chain; clean, simple feasible modularized technology	Strengthening the viability of the customers and communities that they serve
Stræto bus company	To raise their public profile and draw attention to clean transportation efforts	Public transportation is best for all
University of Iceland	To draw the attention to the trans-disciplinary research possibilities	Future posts for researchers and social accumulation of sustainable energy-expertise
IceTec	Following their mission based on connecting environment, technical advancements and research.	To understand the main components of a hydrogen system and its operation
Icelandic Government?	Draw hydrogen demonstration projects and research funds to into Iceland	Our image is clean in the globalized economy

6. STEP THREE: Understanding ‘participatory’ decision-making: negotiating expectations

In the following section the role of over 20 representatives from various corners is described. The preparations were spread to many key institutions, key people and powerful stakeholders in the beginning. Backed up by a strong (and broad) political will, stakeholders were willing to come to the table, thus representing all shelves of society. The approach was cross-sectoral, cross-national, cross-disciplinary only to set a first set the basis. Common goals were established already two years before the project started. The negotiations for the eventual operation started later and yet again, the key people showed to be willing and able. And equally important, all participants were allocated responsibilities and duties which they have carried out with bravura.

What (mix of) mechanisms (formal and informal) were used? How were the interests of various actors aligned?

No theoretical framework for the communication or co-operation or transition management was set up. It was more or less former personal and professional contacts that the participants had established earlier that made up the grassroots for the hydrogen ideas. The mechanisms used in the establishment were the following:

- Parliamentarian committee discussion and workshops[15] 1997
- Formation of a group of experts and stakeholders
- Foundation of a seed company - entrepreneur to carry out the ideas from the group of experts
- Allocation of the execution to that company
- Invitation to participate in the realization of the set goals
- One to one meetings with heads of departments and directors and the city mayor
- Meetings in smaller groups with the actual staff
- Presentations to all the people concerned
- Presentation to the public
- Interviews with the media
- Social survey on attitudes towards deployment of hydrogen - over 90% support for the idea
- Introductory letters and prospects for hand outs on meetings, conferences, congresses
- Web site based information
- Animated school material shown on best time in the state broadcasting TV
- Multimedia material donated on a CD to all the schools in Iceland
- Lots of presentations to the public
- Lots of interviews with the largest international media correspondents
- Second survey made on board the buses - again overwhelming support and positive perception of hydrogen as a fuel
- International attention growing
- ECTOS comes to an end August 2005
- All reports on the outcomes are published in the website www.newenergy.is, Feb. 2006.

The following paragraphs only pinpoint the main participants in the ECTOS case.

The effort was launched by a parliament appointed committee, lead by an MP. The members were: A specialist from an oil company, a local car retailer, a head of department for applied environmental research, a university professor in chemistry, a specialist on battery cars actually working in promoting new business ventures, and a car expert working in tourism. They came together to formulate suggestions on how to proceed implement and follow up the energy policy on local new fuels.

The ideas for ECTOS emerged and as a first gesture Icelandic New Energy was founded hiring an executive for the ideas. The energy companies and others paid their share to establish the company. Mr Jon Björn Skulason, the executive acted a spokes-person for all Icelandic shareholders in Vistorka (the major local energy companies) and got them synchronized, he applied to the EC and again got the foreign investors aligned. Shell hydrogen, Norsk Hydro and DaimlerChrysler became partners in the ECTOS project, as well as the company. They submitted their equipment plus the funds needed for maintenance and monitoring of the technology during the project.

The executive of INE carried out all the main negotiations for the organization and execution of the project ECTOS with the eventual operators, the city bus company, Skeljungur (Shell in Iceland) and the operation of the maintenance facility for the buses, (retailer of DaimlerChrysler in

[15] Led by Mr Hjalmar Arnason, member of the progressive party and well known for his active promotion of hydrogen for Iceland and the world. http://www.althingi.is/cv.php4?nfaerslunr=251.

Iceland, Ræsir). Also four participants would be involved in the data sampling and analysis of the impacts of the project; IceTec for the efficiency tests and environmental impacts, Vinnova in Sweden and the University of Stuttgart (who by that time had been contracted to do the analysis for CUTE) for the analysis and comparison of the impacts from hydrogen traffic, the Icelandic Technical Institute for the fuel efficiency study, and lastly the University of Iceland for the socio-economic research.

For the operational parts within the project, INE ended up holding most of the responsibility for the administration, - all paperwork more or less ended on its desks. The daily routine was allocated to the partners for more detailed day to day work. The buses were leased to the bus company who denied seeing to the maintenance of the buses. The city of Reykjavik owns majority in the bus company and allocated the wages of one driver during the whole project period. In later stages the city also allocated funds (Hy-Fleet:CUTE) to operate the hydrogen buses.

A person was hired for the funds allocated to the University but strategically placed the INE office - acting as a go-between the two levels. Also, the contact person with the University department that was appointed the chairman of the board of directors for INE even thought e Icelandic New Business Venture Fund[16] had put by far the largest investment into the shares.

Within the oil company, Skeljungur, the retail manager saw to the negotiations with the planning department of the City and had a hard time in convincing the retail department at Shell international (their connection into Shell int.) to be flexible for their branding. At that time the oil companies in Iceland were going through a rough time and negative public attitude because of bending the law on competition. Skeljungur did not succeed to get the piece of land they were pleading for within the city and their participation was jeopardized until they decided to sacrifice one of their most valued private lots for the hydrogen station. The original plan was to build a mixed new-energy technology park on a gasoline depot and win the image - game for a modern and concerned oil company placed in a visible lot within the city.

After Skejlungur settled in on one of its own pieces of land, too small to realize the whole idea lots of valuable time had been lost. Then the department of health and safety and the planning department demanded an introduction to the future neighbors of the hydrogen station. This takes normally 10-13 weeks and everybody can file complaints about the plans in a series of negotiations.

After 10 weeks of silence the Skeljungur representative called all the neighbors to urge them to make their comments as soon as possible. Nobody made negative complaints, nobody showed concern and moreover the comments were positive and urging to go forward. NO mpore information was needed. Probably the most remarkable comment was: “Just remember to invite me to the inauguration”

Then the entrepreneurs that set up the driving profiles, the students that carried out the surveys, the research students working within the LCA study and the environmental impact study, the experts that installed their counting devices on the buses, the senior citizens that lent their load in the check for fuel efficiency, the guest students the bus drivers, the maintenance team, the hydrogen station team etc. etc. etc. are not mentioned inspite of their relentless input into the ECTOS project.

[16] Icelandic New Business Venture Fund, Nýsköpunarsjóður atvinnulífsins is an independent investment fund that gets its money from the local industries and fisheries. www.nsa.is.

7. STEP FOUR: From visions to actualities

How was the vision translated into action?
Still there were issues that arose during the implementation phase because of unexpected mishaps therefore changing the outline and the execution of the project. But none of these posed a major obstacle and were solved during the project period.

The allocated funds for the construction of the electrolytic hydrogen station did not cover the cost of the design with a double electrolyzer. The other partners were not ready to put up the difference between the funding and actual cost so the design of the hydrogen station had to be changed. This was accepted in the partnership.

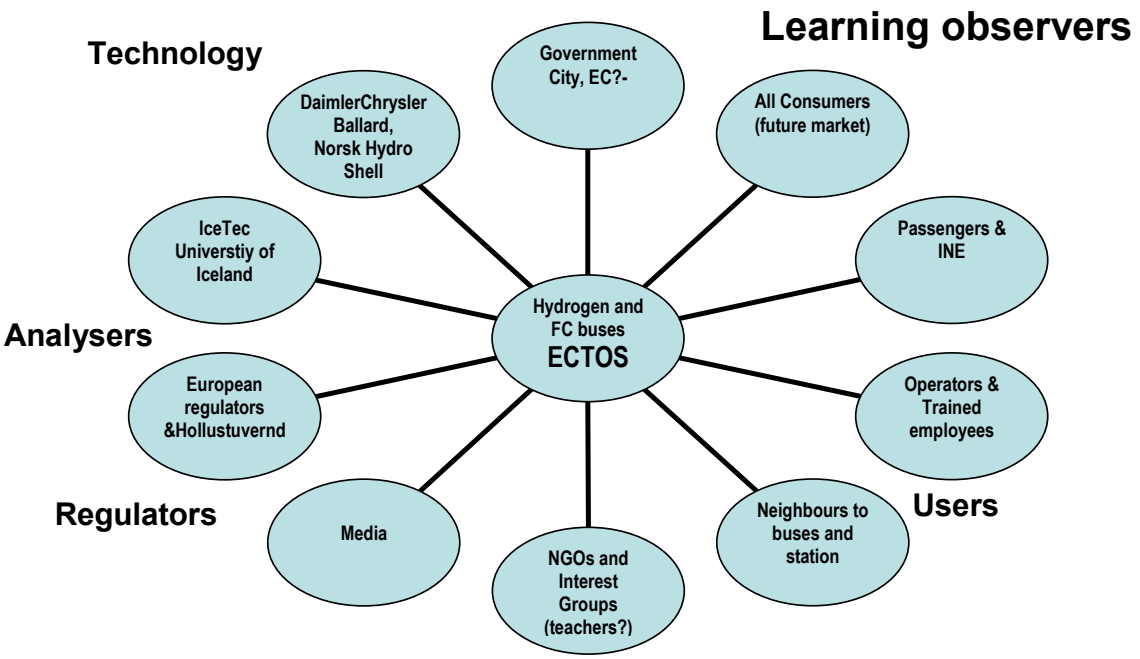

Figure 7.1 *The specified stakeholders in ECTOS compared to the suggested temptative map from the introduction of Create Acceptance meeting no 1 - Eva Heiskanen*

The station had to be shut down for a period of 6 months, but after that the project was continued and prolonged by the 6 months and the station which had went through a thorough inspection and partial redesign has been running smoothly for 18 months.

The partners have been supportive and flexible and barriers have been overcome without any major halts in the execution of the project. The problems have been solved be extra input and effort from all partners but probably the most important factor was the long foreplay, the clear common goals and communication on personal notes.

- *Did this result in adapting the initial objectives of the vision?*
- *How did this occur over time? (i.e. as an unfolding and adaptable process)*
- *What were the key lessons of the transition process at different points in time?*

The ECTOS ended in August 2005. Still the vision is to continue and implement the next step of INE's vision (see Figure 7.1) but the implementations have come to a halt. The main obstacle is probably lack of effort from the governmental level. The ministry of foreign affairs and the ministry of Industry have been the contacts into the governmental level during the ECTOS time and have presented the visions of the company to large international bodies such as the UN, UNEP, Nordic council, Arcitc council, not forgetting the US senate, Indian president, Canadian gover-

nor and more. A cross - departmental committee has been founded in 2006 to formulate the next suggestions to further integrate hydrogen into society. Still the government has not passed any decision on the subject and in July 2006 all major governmental undertakings were paused. The posts of the prime minister, minister of industry and commerce and the minister of foreign affairs have been allocated to new persons recently and the economic situation is unstable. The future of hydrogen is uncertain.

8. Lessons learned

The report no 17 - Total impact assessment - gives a list of outcomes of the ECTOS project on four pages (10-13).[17] But perhaps the question 'What should have been done otherwise' would give more insight to dilemmas.

One stakeholder has been missing from the consortium from the beginning. That is the Energy Authority of Iceland. The role of the institute is twofold:

- To advise the government on energy issues and related topics.
- To carry out energy research and provide consulting services related to energy development and energy utilisation.

Since the launch of the projects the Energy Authority has been observed to make rather negative remarks and show scepticism towards the idea of integrating hydrogen with the speed indicated in INE's roadmap. A representative from them should have been involved in the ideas from the onset and offered to become a shareholder in INE.

Also it can be stated that a clear separation should have been made between the companies policy and road map and then that of the government. Still a hydrogen road map for the government and a clear executive plan has not emerged from the governmental side.

[17] The ECTOS reports, del 17; http://www.newenergy.is/newenergy/upload/files/utgefid_efni/ectos_17-total_impact_assessment.pdf

References

'In the forefront in the new century' Governmental policy statement, in Icelandic and English. The office of the prime minister of Iceland May 28th 1999.

Arnason Bragi (1980): *Hydrogen and hydrogenated compounds. Its production and uses as substitution for imported fuel*. Icelandic report made by the Institute of Natural Science, University of Iceland; for the energy Authority. rep OS80026/JHD15 for a work group on hydrogen and hydrogenated compounds.

Brown, Halina and Philip J Vergragt (2004): *Policies for social learning Bounded Socio-Technical Experiments*. Paper for Berlin Conference on the Human Dimensions of Global Environmental Change 'Greening of Politics- Interlinkages and Policy Integration' Berlin 3-4 December 2004

ECTOS deliverable 12: Social Acceptance - and for comparison to acceptance studies in ECTOS deliverable 17: Total impact assessment. www.newenergy.is/en/publication/ectos%5Freports/

ECTOS deliverable 13 transferability: www.newenergy.is/en/publication/ectos%5Freports/

ECTOS reports, deliverable 17; http://www.newenergy.is/newenergy/upload/files/utgefid_efni/ectos_17-total_impact_assessment_.pdf

Eldsneytisspá 2001 - 2030. OS-2001/040. *Fuel forecast, final report from the official forecasting committee*. English summary provided. Available online at: www.os.is or www.orkuspa.is. ISBN: 9979-68-076-8

Further information on the shareholders are to be found on INE's website: www.newenergy.is

Hagstofa Íslands, icestatistics www.hagstofa.is

Hjalmar Arnason, member of the progressive party and well known for his active promotion of hydrogen for Iceland and the world. http://www.althingi.is/cv.php4?nfaerslunr=251

http://samorka.is/Apps/WebObjects/Samorka.woa/1/swdocument/1000309/Vetni+-+eldsneyti+framt%C3%AD%C3%B0arinnar+-+J%C3%B3n+Bj%C3%B6rn+Sk%C3%BAlason%2C+N%C3%BDOrka+ehf.pdf

Institute of Applied social Sciences, University of Iceland (2002): *Afstaða Íslendinga til vetnis,* Dec 2001; public attitude towards hydrogen, coordinator: Aevar Þórólfsson, Jan 2002.

Landsvirkjun, the national power company, www.lv.is/karahnjukar

Maack M., ed.: *Reports from ECTOS no 17 Total impact assessment* www.newenergy.is/newenergy/upload/files/utgefid_efni/ectos_17-total_impact_assessment_.pdf

Maack, M. and J.B. Skulason (2005): *Implementing the hydrogen economy.* International journal of cleaner production, Volume 14.1, 2005 pub. Elsevier.

Minstry for Industy and Commerce (1994): *Innlendar orkulindir til vinnslu raforku (Domestic sources for the production of electricity with an overview on sources of hydropower and geothermal power)*. Ed. The Icelandic Energy authority, Orkustofnun, www.os.is

Minstry for Industy and Commerce (2003): *Towards a sustainable hydrogen economy in Iceland.* Uploadable from www.newenergy.is/newenergy/upload/files/brochures/tshe_brochure.pdf

Reykjavik's Energy service, Geothermal uses. Available online in English at: www.or.is

Skulason, J.B. (2001): *Vetni eldsneyti framtidarinnar; Orkumenning a Islandi, Orkuthing 2001*. Conference proceedings of the national energy summit in Oct 2001, Energy Culture in Iceland. Hydrogen the fuel of the future, Pb: Samorka Iceland.

Icelandic New Business Venture Fund, Nýsköpunarsjóður atvinnulífsins is an independent investment fund that gets its money from the local industries and fisheries. www.nsa.is

Vistorka, Eco energy
www.newenergy.is/newenergy/upload/files/brochures/vistorka_brochure.pdf

Pers communication with

Sigfús Ingimarsson ambassador for Germany in 1995 - 2000. and

Bragi Arnason Professor

Ingolfur Thorbjörnsson, head of environmental department of IceTec, 11th July 2006.