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**A STUDY OF THE EXPERIENCES OF HYDROGEN COMMUNITY
PROJECTS IN EUROPE AND WORLDWIDE**

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The European Commission is supporting the Coordination Action "HyLights" and the Integrated Project "Roads2HyCom" in the field of Hydrogen and Fuel Cells. The two projects support the Commission in the monitoring and coordination of ongoing activities of the HFP, and provide input to the HFP for the planning and preparation of future research and demonstration activities within an integrated EU strategy.

The two projects are complementary and are working in close coordination. HyLights focuses on the preparation of the large scale demonstration for transport applications, while Roads2HyCom focuses on identifying opportunities for research activities relative to the needs of industrial stakeholders and Hydrogen Communities that could contribute to the early adoption of hydrogen as a universal energy vector.

Further information on the projects and their partners is available on the project web-sites www.roads2hy.com and www.hylights.org



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1. Structure of the Report

The report is structured in the following way:

- 1) A general part, which gives an overview of the objectives and approach.
- 2) A summary of the findings from all projects divided into conclusions and recommendations.

Section 2 gives general conclusions on success criteria and specific conclusions in relation to the metrics. It will also treat other points relevant to the WT3.2 assessments.

2. General Part

2.1 Summary

This paper documents a study that looked at identifying the criteria for long-term success of hydrogen community projects, based on the experiences and lessons learned from relevant initiatives worldwide. The study was based on interviews with project managers from eleven demonstration projects, of which nine are specific to hydrogen (H₂) and/or fuel cell (FC) technology and two to general environmentally friendly energy technologies. These projects have all been carried out in different parts of Europe.

The study exposed a number of critical factors that have been crucial for project success:

- Determination of the people involved in the project.
- Good relationship between project promoters and component suppliers.
- Local expertise in technical and administrative issues.
- **Political and institutional support at different levels** (local, regional, national or supra-national). Political or institutional support can help initiate and legitimise the project.
- **The local community's acceptance of the project.** Various ways of securing an interest and acceptance from the community have been used in the investigated projects. The concrete realisation of the site and need for sustainable energy supply are major factors for mobilising community acceptance.

2.2 The objective of the study

The objective of the study was to gather experiences from demonstration projects and relate the results to the metrics developed in Work Task 3.1.1 (see Table 1 and



Table 2). The aim was to supplement the methodological framework by proposing success criteria to determine what may constitute long-term sustainable hydrogen-integrated communities. These success criteria will help to validate the metrics and sub-metrics developed for the methodology as being important for achieving a sustainable hydrogen-integrated community. Furthermore, the study provides supportive information for identifying the most decisive metrics to consider when assessing communities' success potential, and thus those metrics that should potentially have a greater weighting in the WT3.2 assessment process.

Table 1: Grouping of metrics and their definitions

METRIC	No.	Rating	Driver (D) / Capacity (C)	Definition
Technology Accessibility	1	0-4	C	Access of the community to relevant hardware, expertise
Global Environmental Impact	2	0-4	D	Motivation of the community to reduce greenhouse gas (namely CO ₂) emissions
Local Environmental Impact	3	0-4	D	Compliance with regulation and EU EAP
Efficiency	4	N/A	N/A	Not relevant for communities: the technology / pathway efficiency would be reflected in other end user (community) concerns e.g. cost, environmental impact, evaluated elsewhere by other metrics
Capacity & Availability	5	0-4	D	Need of community for new / increased energy and / or hydrogen supply to meet end-user demand
Cost	6	0-4	D	Expectations for cost-competitiveness of H ₂ /FC technology
Safety	7	N/A	N/A	Not relevant for communities: it is assumed that no technology would be deployed unless meeting minimum (certified) safety criteria. Evaluated in the "Technology" metrics.
Public Acceptance	8	0-4	C	Degree of openness of the local community towards integration of alternative energies (H ₂ &FC in particular)
Political Will	9	0-4	C	Level of political (framework) support, financial mechanisms, non-financial assistance for alternative energies (H ₂ &FC in particular)
Security & Sustainability	10	0-4	D	Need of community for increased energy independence / security
Potential for Project Continuity, Growth & Sustainability	11a	0-4	D	Need for increased economic competitiveness of area (new business creation, jobs)
Potential for Cluster Development	11b	0-4	C	Potential for formation of self-sustaining network of H ₂ &FC / energy-technology related activities

Table 2: Overview of Metrics, Sub-metrics and Guideline Examples for Rating



METRIC	No.	Generic Sub Metric
		Presence of suppliers of H ₂ FC technology and expertise in region = Local suppliers of expertise/H ₂ FC hardware (WP1 data) AND/OR Level of <u>demonstrated activity</u> of local+external companies in the region (as measured by installed FC units in region)
Technology Accessibility	1a	
Total score metrics above		
Global Environmental Impact	2a	Degree to which targets/strategies for CO ₂ -reduction that are relevant for the potential community exist
Total score metrics above		
Local Environmental Impact	3a	Degree to which the potential hydrogen community suffers or can be expected to suffer from chronically environmental problems
	3b	Existence of targets/strategies for impact reduction e.g. industrial or (transport) sector relevant for the potential community?
Total score metrics above		
Efficiency	4	Not relevant in WP3
Capacity & Availability	5a	Expected demand i.e. need for new/increased energy availability
	5b	Degree to which early adopters/private users of H ₂ FC technologies exist within the community?
Total score metrics above		
Costs	6a	Potential for future cost reductions in the application proposed by the community. When is technology /application expected to be competitive?
Total score metrics above		
Safety	7a	Not relevant in WP3
Public Acceptance	8a	Expected or Demonstrated degree of openness/acceptance of H ₂ FC technologies from local communities & NGOs
	8b	Level of activity H ₂ FC associations in the region
Total score metrics above		
Political Will	9a	Level of public financial support for H ₂ FC (As measured by financial incentives for R&D, demonstration desktop studies)
	9b	Extent of subsidies available to offset capital costs (subsidy as % of estimated capital cost (where possible)
	9c	Availability of other (indirect) financing instruments e.g. tax breaks)
	9d	Is pre-project assistance available for the potential community?
	9e	"Documented" (theoretical) political support
	9f	"Demonstrated" (proven) political support (Community track record - other energy, transport or sustainability initiatives (including H ₂ FC projects)
Total score metrics above		
Security & Sustainability	10a	Degree to which H ₂ -FC alternative offer significant increases in energy independence & security
	10b	Are there programmes/policies in place to promote energy independence?
Total score metrics above		
Potential for Project Continuity, Project Growth & Sustainability	11a	Current (un)employment situation compared to national average
	11ab	Potential for creation of new H ₂ FC industries/companies in the community as a result of the H ₂ FC initiative
	11ac	Potential long-term job creation for <u>local people</u> as a result of the H ₂ FC initiative (ie. The skilled force is not imported with the project, local people are trained) (10-yr perspective)
Total score metrics above		
Potential for Cluster Development	11ba	Concentration of LOCAL companies active in H ₂ &/or FC or related areas in proximity of community(refer also Metric 1a - WP1 mapping) AND/OR Indication of private/corporate investment in H ₂ &/or FC or related areas (related areas can refer to "energy" in general or to any part of the H ₂ FC chain: component manufacture, supply, or use)
	11bb	Presence of specific knowledge & expertise (research community) in H ₂ FC and/or new energy concepts in proximity of the potential community
	11bc	Degree to which professional demanding lead-users or early adopters of H ₂ FC technologies are available within the proximity of the community?
	11bd	Degree to which suitable renewable resources (e.g. biogas, biomass etc.) are available within the proximity of the community?
	11be	Track record of potential community with respect to previous or other CQ reduction or environmental initiatives?
	11bf	Potential for replication of the demonstration project(s) elsewhere/in other communities?
Total score metrics above		

The assessment process itself is described more fully in the Roads2HyCom methodology Manual R2H0603CO, with further detail on application to Community assessment in R2H3004PU.

The information was primarily obtained from semi-structured interviews with the key stakeholders from the selected demonstration projects. Particular attention was given to acquiring feedback from the stakeholders and their opinion on what constitutes a successful demonstration project from the point of the local "community".



2.3 Approach

Each metric and sub-metric has been categorised as a “driver” or “capacity” (see Table 1). These categories are defined as:

- **Driver** The motivation of a community in exploring or implementing the adoption of H₂ &/or FC applications
- **Capacity** Inherent ability or capability of a community to accommodate and integrate disruptive energy technologies (e.g. H₂-FC) within their energy system

The paper seeks to validate and rank the “drivers” and “capacities” of the investigated demonstration projects with regards to the metrics.

The analysis mainly concentrates on the following “capacity” type metrics:

- **“Metric 1 – Technology Accessibility”** reflects the ability of the community to procure technology relevant to its needs and the expertise for operation of the technology
- **“Metric 8 – Public Acceptance”** is a sign of acceptance of disruptive (but also environmentally-friendly) technology from local communities and NGOs
- **“Metric 9 – Political Will”** reflects the political push for the technology, as demonstrated by the level of public financial support as well as other kinds of political and institutional support
- **“Metric 11b – Potential for Cluster Development and Community Growth”** reflects the potential for creation of new industries around the community, long-term job creation, and the potential for knock-on effects in the creation of similar hydrogen community type initiatives elsewhere

Where sufficient information was obtained from the interviews, some general conclusions about the “need” type metrics have been made.

In the overall evaluation of the success potential of a hydrogen community, the relative significance of each metric varies. Moreover, the relative significance (or weightings) may change for different categories of communities. For example, technology accessibility may be of more importance for small, remote communities than for large, well-networked ones. This paper, therefore, uses the experiences and lessons learnt from relevant demonstration projects to draw general conclusions about the relative importance of different metrics for various community types, in the context of achieving long-term success.

The analysis focuses on how the metrics relate to different community types or profiles and also for various types of (technology) application. When the interview material reveals different tendencies between different types of community types it will be discussed further.



The different community types considered were:

- **Cities** Densely populated, urban areas
- **Islands/Remote Areas** Sparsely populated and/or isolated areas
- **Regions** Larger administrative areas encompassing towns, cities, remote areas.

The main application types and their basic features considered were:

- **Industrial sites, urban complexes:** base load power, CHP for industrial/commercial buildings and complexes e.g. CHP in hospitals
- **Transport:** public, mass, cargo transportation and related infrastructure e.g. FC vehicles, buses and fuelling stations
- **No specific location:** private and specialised fleets e.g. scooters
- **Isolated and (semi-) autonomous:** micro power / CHP for residential use, off-grid applications

2.4 Quality of Information

A total of fourteen potential demonstration projects were identified by Icelandic New Energy (INE) and other Roads2HyCom partners. Where possible, the Roads2HyCom interviews were coordinated with HyLights (Coordinated Action (CA) – oriented towards hydrogen demonstration projects within transportation) in order to avoid overlapping interviews and confusion.

These 14 demonstration projects were considered to be of a reasonable scale and had existed long enough to generate relevant experience. The selected projects vary in their geographical scale and location, in technology application and in community type.

Table 3 shows the distribution of projects according to administrative or geographic units (rows) and type of applications (columns). Some projects (for e.g. Tees Valley and PURE) are based on more than one type of application and, therefore, fall in to more than one category.

The interviews were carried out by Risø National Laboratory, Icelandic New Energy, and the Joint Research Centre – Institute for Energy. The interviewees were project managers of the identified demonstration projects. These project managers have been heavily involved in the different phases of setting up and carrying out the demonstration projects. On one hand, the position of the interviewees, as project managers, provides this report with direct access to first-hand and “real life” experiences with demonstration projects. On the other hand, their position might create a bias in their assessment of the performance of the project. This possible bias is taken into consideration in the paper’s analyses and conclusions.

The following section will first describe the specific conclusions with respect to the four metrics mentioned above, and, then, present some general conclusions regarding knowledge creation, community benefits and project realisation.



Table 3: Distribution of demonstration projects analysed

	Transport Infrastructure	Industrial Sites / Urban Complexes	Isolated, Autonomous Applications	No Specific Location	Total
Cities	ECTOS (HyFleet: Cute Project) CEP-Berlin H2MUC	GlashusEtt		UseH2Backup	5
Islands	PURE-project (UK)	Res2H2	PURE-project (UK) Utsira Kythnos		4
Regions	Tees Valley Region Nord Pas de Calais	Tees Valley Region			2
Total	6	3	3	1	11

3. Conclusions and recommendations from overall analyses

3.1 Specific conclusions

This section examines the main findings from the interviews in relation to the metrics listed in Section 2.3. The overall conclusions from the study are outlined in Table 4.

3.1.1 Metric 1 – Technology Accessibility

The selected demonstration projects differ in terms of the type of energy technology employed (see Section 4.2).

Given the specific characteristics of each demonstration project, most of the interviewed projects have been confronted with different kinds of technical challenges. Obviously, implementation of immature technologies can give rise to unforeseen incidents, particularly at start-up, which may induce increased costs and delays. This was true for all the selected projects. However, from a long-term perspective these types of technical obstacles were not considered to be of decisive importance for project success.

Access to technical expertise and know-how proved to be a more crucial issue. The interviews indicated that demonstration projects in remote areas, such as islands, experienced more difficulty in accessing technical expertise and assistance. Several of the interviewees from remote areas reported poor accessibility to technological support, mainly because of longer distances to relevant sources of knowledge.



Table 4: Lessons learned from demonstration projects

METRICS	LESSONS LEARNED	
	IN GENERAL	SPECIFIC TO HYDROGEN COMMUNITY PROFILES
Technology Accessibility	<ul style="list-style-type: none"> Local ownership and access to required technological knowledge is of great importance Require long-term contingency plans for accommodating plant, maintenance, upgrading errors and so on 	<ul style="list-style-type: none"> It seems more difficult to ensure the accessibility to technology and knowledge from component suppliers if the project is in a remote areas, such as islands
Public Acceptance	<ul style="list-style-type: none"> Early involvement of the community helps to solve a number of problems that might arise, ensures local political support and facilitates the overall process of project implementation Concrete realisation of the demonstration plant fosters increased public acceptance, goodwill and reduces the 'fear-factor' 	<ul style="list-style-type: none"> Islands and regions seem to be more focused on creating a community commitment to the project than larger cities. An explanation for this may be that projects in cities are, to a larger extent, carried out by larger companies whereas on islands project promoters often have a stronger local anchoring
Political Will	<ul style="list-style-type: none"> Political support from local, regional, national and/or supranational institutions is very important when setting-up and carrying out the demonstration project, from the point of view of: <ul style="list-style-type: none"> ✓ Mobilising awareness to environmental / renewable energy (EU/National) ✓ Promoting public acceptance ✓ Assisting projects through non-technical barriers 	<ul style="list-style-type: none"> No differences between community profiles have been registered Differences between national and regional financial structures / systems under which the demonstration project takes place can affect the importance of the support at different levels
Potential for Community Growth	<ul style="list-style-type: none"> The interviews only show vague indications of emerging ties between businesses, suppliers and associated institutions. This might be because it is still too early to expect any cluster development from a couple of demonstration projects. 	<ul style="list-style-type: none"> Communities with a strong 'driver' for security of energy supply, such as remote islands, are more likely to expand in size A 'driver' to create jobs and to promote local and regional industry appears to be stronger in regions and in islands than in cities In the case of cities, a 'driver' to promote the city as environmentally-friendly seems to be the main project driver



The presence of technology suppliers in the region is an important factor for project success. In fact, when no technology suppliers are located in the region, there would be initiatives to build up local expertise through practice and training activities. For example, the PURE Project, which is located on the most northerly island in the UK, considered that it was important to retain ownership and technical understanding of the technology involved. In the tender process, the proponents from the PURE Project paid special attention to the level of knowledge-transfer that component suppliers were able to give them. They wanted a supplier that would deliver the technology they needed to install at the site and also supply the technical knowledge, training and understanding so they could operate and maintain the plant on their own.

Another point from the interviews was that shorter distances to component suppliers lead to a greater advantage in developing and adjusting the demonstration site. In general a good relationship with component suppliers is crucial to the development and maintenance of the site. Interaction with component suppliers leads to creation and sharing of knowledge resulting from the project. This important role can be dependent on the geographical distance.

Most of the projects (especially islands) experienced some level of difficulty in gaining access to and ownership of the required knowledge. The general experience was that it was not a problem to find a company that could supply the technology, but it was difficult to find local people with the practical experience for running the demonstration site.

The importance of assessing the competencies of the technical and industrial partners was also highlighted. One of the project managers stressed the importance of assessing suppliers' expertise and capacity to deliver what was expected in order to avoid unnecessary delays and disagreements during the project.

In summary, a local community intending to set up a demonstration project must be prepared to face a number of technical problems. Ideally, there should be a long-term contingency plan that accommodates for plant maintenance, upgrades, errors etc. Furthermore, it is of great importance for demonstration projects on islands to retain local ownership of the process and learning from the development, design, installation and operation of the system. This is less important for demonstration projects in regions and cities, but they may benefit from an easier access to knowledge. For example as a result of proximity to high quality universities and research institutes.

3.1.2 Metric 8 – Public Acceptance:

Metric 8 looks at how well the public (mainly, local communities and NGOs) accepts disruptive (also, environmentally friendly) technology. According to the interview answers, it is difficult to assess the level of public acceptance of the demonstration project. First, because the interviewee (project manager) is likely to be biased in his or her assessment of how well the public accepts the technology and, second, because public acceptance may change over time. Therefore, this section focuses on how the different projects address matters of public acceptance, such as involvement of the community.



The demonstration projects investigated used different approaches with respect to community involvement, which depended on the type of application and objectives of the project. For instance, demonstration projects at industrial sites seemed to have less focus on the surrounding community than, for example, a project providing energy for domestic use.

It became apparent from the interviews that the process of informing and engaging the public differs between projects. For example, the 'PURE Project' (see Text Box), had community involvement at the forefront of its objectives. An initial purpose of the project was to have a working renewable hydrogen system that was owned by the community. On the other hand, other projects, such as the Kythnos-project and the North Pas de Calais-project, did not initially set out to involve the community but realised during the establishment and operation of the project that it was of great importance to have a good relationship with the local authorities and residents. In the Kythnos-project the engagement of the community was at a much later stage. In the North Pas de Calais-project community involvement was found to be extremely important at the time of introducing the technology into the market.

Most demonstration projects reported that it had been an advantage to engage constructively with the local community. In their opinion the decision to include the community has proved positive, as it helps to ensure local political support and facilitates the process in general. Furthermore, community involvement created awareness and trust. Local authorities were more willing to participate if they could serve some of their constituents via the demonstration project.

The examples given here suggest there is a difference in the way of addressing community issues that depends on the type and location of the demonstration project. In the case of the PURE Project, and other local and regional framed projects, they have had to rely more strongly on public acceptance and commitment. Whereas in cities, where the main promoters often are larger companies, there tends to be less focus on community involvement

Text Box: Local Ownership as a means to ensure public acceptance...

In the case of the PURE Project a concept of local ownership of the hydrogen production for local consumption was developed by two of the partners in the project.

Even though the PURE Project was initiated by this idea of a community owned renewable hydrogen system, the local community was somewhat sceptical prior to starting up the project. Furthermore a fear of hydrogen technology pervaded the community.

The actual realisation of the demonstration site of the PURE Project mobilised the community's support and overcame the sceptical attitude and the 'fear-factor' in the community.

Another way of overcoming the community's doubt and fear was through involvement of political figures or other trusted people that could generate confidence in the project. For instance, a local engineer who used to repair people's computers was developing the technical site. It made people ready to accept the project because they knew: "That he (the local engineer) knows what he is talking about."



3.1.3 Metric 9 – Political Will

All the demonstration projects were partly funded from public sources (usually between 40-90%). The rest of the funding came from various private partners. For most sites the (private) partners involved own the plant at the end of the demonstration period. In most cases, partners had agreed on a contract that ensures them access to the plant in a limited period after the end of the project. For the PURE Project, the community and a regional development organisation intend to own the site after the demonstration period.

Political support from local, regional, national or supranational institutions is very important when setting-up and carrying out demonstration projects. The high prioritised environmental agenda in the European Union and numerous national governments ensures financial support for many demonstration projects. At the local level, support from local authorities (e.g. a mayor or other trusted persons in the community) can help legitimise and increase the confidence in a demonstration project within the community. Political support is also important when a project is facing non-technical barriers.

In some cases, political support was not present in the project's initial phase, but was gained later when the demonstration site came into realisation. Further on, when the site showed good results, local or national politicians saw good potential in being associated with the project.

Some projects experienced difficulty in gaining the necessary support and interest from the national political level. Lack of interest at national level has, in these cases, meant lack of financing from national institutions. Therefore, it may be concluded that political support from all levels should to be taken into consideration when starting up a demonstration project.

The overall assessment is that political support and backing is very important for disruptive or alternative energy projects, not only to promote public awareness and ensure financial support, but also to initiate a project and to assist projects through any difficulties arising.

3.1.4 Metric 11b – Potential for Cluster Development and Community Growth

A cluster can be defined as a geographic concentration of interconnected businesses, suppliers, and associated institutions in a particular field. Clusters are considered to increase the productivity with which companies can compete, nationally and globally. The studied demonstration projects did not reveal any clear results in regards to cluster development. This might be because it is still too early to expect any cluster development from a couple of demonstration projects.

However there were vague indications of emerging ties between businesses, suppliers and associated institutions. For instance, most interviewees described the importance of a good relationship with component suppliers (see Section 3.1.1). Demonstration projects carried out in remote areas have experienced severe problems in building up strong ties to suppliers mainly because of their location. Therefore it seems regions and cities have the advantage of proximity to component suppliers.



Ties between universities and project promoters also played a role in some demonstration projects. For example, demonstration projects in regions and cities often point to regional universities or research institutions as an important source for gaining the required knowledge. On islands they had a stronger focus on building up local expertise by practise and training activities. These findings indicate that the potential for cluster development is larger in cities and regions than in remote areas.

Several projects in the study have lead to community growth or the creation of new jobs. These projects are diverse and include demonstration projects on islands. For example, the PURE Project has directly led to creation of a new business and to seven new jobs.

In the case of the Kythnos Island Project, there has been a growing interest from residents on the island to take advantage of the project's results, and to incorporate them in an extension of the electricity supply. This can be seen as a potential for community growth. A conclusion can be made with respect to the "drivers", in that communities with a strong need for energy supply (e.g. at remote islands) and energy security can give rise to community growth. These "driver" factors are also important for project success.

It should be noted that this study did not find any signs of project replication or knock-on effects in other sites or communities. However, it may be too early for such effects to be seen.

3.2 General conclusions

The main driving forces behind the demonstration projects were to introduce new (and still immature) technology, identify problems and to solve these problems. Furthermore, energy security and energy supply were also important driving forces.

Job creation and the possibility to generate growth were, in some cases, a major driving force, while in others they did not appear to be important. The interviews indicated a slight difference between cities, regions and islands. Projects in regions were more likely to be initiated with the goal of creating jobs than projects in cities and on islands.

Obviously, demonstration projects for cleaner energy will, to a certain extent, always involve environmental issues. But such issues did not appear to have been the main driving forces. Nevertheless, the interviews indicated that for transport related projects and projects carried out in urban complexes, local and global environmental concerns plays a much greater role than is the case in rural, isolated or island applications. This might be because environmental issues are more evident in cities than in remote areas.

Common to all the demonstration projects was the fact that they have *primarily* been focused on technological learning and energy supply and security. The main driving forces are also mirrored in the main proponents in the different demonstration projects. These were primarily the European Union, regional or national authorities, universities, research institutions and companies, *not the broad community*.

Knowledge learned from demonstration projects is typically developed between local stakeholders of a project and component suppliers. Typically, knowledge was



learnt during a demonstration project through doing, using and interacting. Learning by interaction mainly occurred between component suppliers and project owners in developing and integrating components into a functional energy system (Figure 1). The interviewees all confirmed the importance of having a rich relationship with component suppliers. Other players such as academia, financing sources, politicians and the community also play important roles in supporting the project.

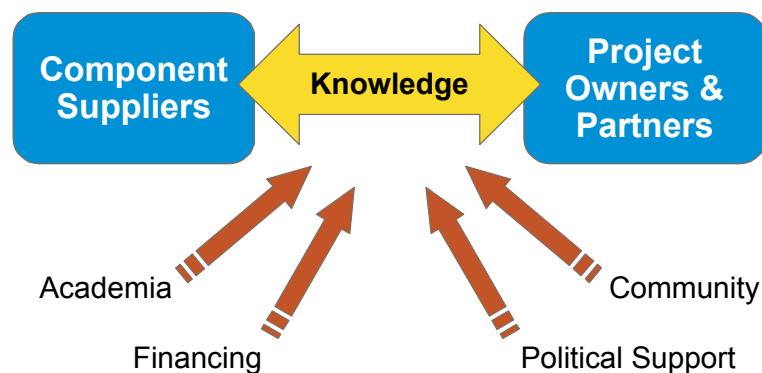


Figure 1: Main knowledge interaction and supportive players

Learning by doing related to activities and experiences gained while operating and maintaining the site. Learning by using related to end users of the renewable energy technology. For instance drivers of H₂-cars in the CEP-project are gathering experiences and information on the vehicle by driving the car and the project partners learn from their feedback on problems and experiences.

The range of knowledge can be divided into:

- Technological knowledge
- Knowledge on how to administrate and coordinate a demonstration project

The project partners (companies, research institutes, universities or different network partners) usually acquired the technological knowledge in the course of setting up, operating and maintaining the project. Dissemination of knowledge happened through training courses, workshops and conferences, as is the case for PURE and Kythnos Projects. Often, the technological knowledge produced in a demonstration project is more complex or systemic than in regular projects. This is because demonstration projects are typically at a higher scale and they require several technologies and components to work together in a system.

Some of the knowledge learned in demonstration projects related to how to run and coordinate the many activities before, during and after the demonstration period. This included applying for funding, holding meetings with partners, and communicating with users and the surrounding community. This can be quite a challenge due to the many European partners involved in these kinds of projects.

In one case the project started out having two coordinators, one scientific and one administrative. But the diverse interests complicated the cooperation between partners. In this process, the European Commission was a major supportive factor and managed to solve the problems between the many partners involved so the



project could continue with only a minor delay. This example points to the importance of the European Commission in giving the necessary support and advice when things go wrong in the partnership.

In summary, the lessons to be learned regarding knowledge creation are not only concerning the technological knowledge but also, to a great extent, on how to ensure the best conditions for project management. It seems that clarity in “ownership” of the demonstration project and its objective is a key premise for a successful and effective project realisation.

The perceived **benefits that the communities have achieved** from the demonstration project vary from one demonstration project to the other. One overall conclusion is that the community benefits are fairly limited. However, this can be explained by the simple fact that the demonstration projects are of a limited size (given they are *demonstration* projects) and, therefore, have a limited impact on the local community in general. Furthermore, the demonstration projects, to some degree, have to use immature technologies with a limited impact. These technologies are still at a research stage and have not yet reached the economies of scale where a wide diffusion of the technology can be easily achieved. The communities may, therefore, not be expected to benefit on a massive scale from demonstration projects in the very short term. For example, it will take more time before a community can have large transportation systems based on hydrogen. The demonstration projects should be seen as one step towards gaining knowledge and experiences that will eventually scaling up into future alternative energy projects.

However, the limited size and impact of the demonstration projects does not mean that the communities have not benefited at all. Looking more specifically at two island demonstration projects, namely the Kythnos and the PURE Project, it can be seen that the demonstration projects created benefits for the communities and achieved their overall goals. The community has benefited from the Kythnos project in terms of a better, more secure and cleaner energy supply in remote areas that did not previously have electricity. Furthermore, because of the history of the Kythnos Island with its many other energy installations and because of the Kythnos project, the island has become popular among researchers within renewable energy. As a result, workshops, conferences and other activities are being held on the island. This has had a positive effect on tourism and job creation. Similar positive effects can be observed with the PURE Project, which has led to better energy security for a remote area and created seven jobs. During the PURE Project, a new business was created, which is located in the community (the Pure Energy Centre). The Pure Energy Centre business is 52% owned by the community, the rest is privately owned.

In most of the investigated projects the community has benefited from job creation in energy related business. Overall, this strengthens the community and, in the future, can give rise to more energy-related activities.

In summary, the communities have generally benefited from the different demonstration projects in terms of job creation, better energy security and supply, a better utilisation of the renewable energy sources available in the proximity of the community, lower pollution and a general better understanding of the importance and potential for utilisation of renewable energy.



Several things can be pointed out in the assessment of key criteria for effective **project realisation**.

First of all a key factor is to gain financial backing. It has not been a priority for this study to investigate this issue in detail, although it seems that an important factor for gaining financial backing is considerable former experience or track record in soliciting financial support. Interviewed demonstration projects have generally had a track record regarding renewable energy projects. Furthermore, it is clear that gaining financial backing is contingent on the availability of financial support mechanisms. In this respect, a key factor is the provision of relevant financial support mechanisms (see next paragraph pertaining to political support) from national, but also local levels.

Second, political support from local, regional, national and supranational institutions is very important in terms of initiating, legitimising and financially supporting demonstration projects.

Third, participation and determination of the people involved in the project (including component suppliers and other supportive partners) is a key success factor for all the interviewed projects.

Fourth, for all the projects it has been important to ensure accessibility to technology and, not least, the knowledge needed to install, operate and maintain the demonstration plant. Small islands on the outskirts of Europe have experienced even greater challenges regarding accessibility because of physical barriers. For instance, on Utsira it was necessary to rebuild the harbour and infrastructure in order to be able to obtain (by shipment) the components and equipment to run the project.

Surprisingly, the public acceptance and involvement does not seem to be of decisive importance in project realisation. Nevertheless, it is evident that a strong reluctance by community to H₂ and/or FC demonstration project could cause obstacles to project realisation. Given this study's focus on demonstration projects in progress 'community reluctance' has not been covered.

3.3 Considerations to be carried forward to the WT3.2 assessments

In assessing the relative roles of "capacity" and "driver", one cannot clearly say that "capacity" always overrides "driver" or vice versa. They both appear to be necessary for the creation and the long-term success of a demonstration project. This can be illustrated by looking at some of the metrics that were identified to be important in the interview. The "Political will" metric (metrics 9A-9F) and the "Potential for Cluster Development" (metrics 11ba-11bf) are all Capacity-related metrics, whereas the "Security and Sustainability" metric (metrics 10a and 10b) and the "Capacity and Availability" metric (metrics 5a-5c) are Driver-related metrics.

On the basis of the specific and general conclusions presented above, it is rather difficult to assess the relative weightings of the metrics studied. The four metrics are more or less important depending on the community profile and type of application (refer also to Table 4). Furthermore, the importance can vary throughout the demonstration period. For instance, it seems that technology accessibility and political will are of major importance in the early phases of a project whereas community involvement and cluster development has greater importance at later



stages. Although, community involvement (and acceptance) may have an important role in initiating a project, as well as ensuring political support.



4. Appendices

4.1 Interview Guide

The questions used in the interviews are given below, along with the metrics they relate to.

Q1. Please, describe your own role in (or your source of knowledge on) the project?
(Quality of Information)

Q2. Describe the demonstration project and its aims? **(Project Description)**

- What technology (ies) and application(s) were demonstrated in the project?
- What was the aim of the project?
- Who was / were the main proponent(s) in the actual conception and implementation of this particular demonstration project and what was their main short-term and long-term motivation for promoting this project? (E.g.: advancing technological research, gaining visibility / public acceptance, security of energy supply, meeting growing or specific energy needs, local/global environmental issues/obligations, enhancing business creation and employment opportunities, etc)
- What sources of public funding were used? (tax breaks, subsidies, co-financing etc.). **Metric 9a to 9d, Political Will**
- Who were key stakeholders in establishing the project? (E.g. public body, universities, research centres, industry)
Metric 11bb, 11bc, Potential for Cluster Development
- Who owns the demonstration plant after the demonstration period?

Your assessment of the key success factors

Q3. What are the key success factors for knowledge creation?

- Who learnt (or who is expected to learn) from the demonstration project?
- What new knowledge was created in affiliation with the project – either during project development or after inauguration?
- From your experiences on this project what are the key success factors for knowledge creation in affiliation with demonstration projects?

Q4. What are the key criteria (barriers and success factors) for effective project realisation?

- Were there technical barriers to implementation and operation of the project? (E.g. difficulty acquiring the technology components and/or the hydrogen resource, poor performance of technology)
Metric 1a, Technology Accessibility
- Were there non-technical barriers of limitations related to implementation and operation of the project? E.g.:



- lack of specific local expertise in developing / implementing the project, and / or for operating and maintaining the equipment once in place

Metric 11bb, Potential for Cluster Development

- lack of financing **Metrics 9a to 9d, Political Will**
- non-acceptance by certain members of the community **Metric 8a, Public Acceptance**

- If so, how were these barriers dealt with and what recommendations would you give related to avoiding or overcoming these in the future?
- What was the role of political support in the effective realization of the project? Choose from:
 - i. negative influence – the hindered project realization
 - ii. neutral – little or no effect on project realisation
 - iii. positive influence – they were main instigators or key supporters of the project and were central to project realization

Metric 9 (in general), Political Will

- What was the role of other major stakeholders in the effective realization of the project: academia, research institutions, industry (companies), independents?

Metric 11bb, 11bc, Potential for Cluster Development

- What factors were key to gaining financial backing for your project? What financing mechanisms have helped to assure sufficient financing for the given project? **Metric 9 Political Will**
- What general lessons can be taken forward with respect to increasing a community's capacity? **(does not have to relate to a specific metric)**
- Was there any previous experience (track record) with innovative energy projects? Was this a factor (positive or negative) in the implementation of this project? **Metric 11be, Potential for Cluster Development**
- What do you consider to be crucial criteria for consideration (potential barriers, success factors) in the conception, development, implementation and management of such a project? What general lessons can be taken forward with respect to the increasing a community's capacity? **(either related to a specific metric or just generally)**

“Community” Viewpoints

Q5. Community issues – the community in which the demonstration was situated.

- Was the community on board from the start of the project? What was their role, if any, in the realisation of the project? Choose from:
 - i. neutral – little or no role as they were not particularly interested in the project
 - ii. minor resistance – the community had to be “won over”,
 - iii. large role – they were main instigators or key supporters of the project and were central to project realisation

Metric 8a, Public Acceptance



- How can this role be explained – no information, wrong information, other factors? (E.g. if a negative role could be explained by concerns about safety, or if a positive role is explained by a culture of innovation in the community etc.)
- How, if at all, did the community benefit from the demonstration project?
- Who were the most important community stakeholders in the demonstration project?
- What were their roles in the demonstration project?
- What were their aims and motivation for participating in the demonstration project?
 - **What general lessons can be taken forward with respect to the increasing a community’s capacity?
(either related to a specific metric or just generally)**
- Were there any “open minded customers”, lead users or other early/risk taking users in the community?
 - **Metric 11bc, Potential for Cluster Development**
 - If yes, how did they participate in and contribute to the demonstration project?
- How would you characterize the entrepreneurial spirit among the local stakeholders?
 - Was there a tradition for entrepreneurship among academia?
 - **What general lessons can be taken forward with respect to the increasing a community’s capacity?
(either related to a specific metric or just generally)**
- Were the community stakeholders involved in existing and functioning networks (e.g. in collaboration with finance bodies, politicians, companies, academia) and how?
 - **What general lessons can be taken forward with respect to the increasing a community’s capacity?
(either related to a specific metric or just generally)**

Q6. What do you consider key reasons for the success or failure of a demonstration project from a “community” point of view?

- **What general lessons can be taken forward with respect to the increasing a community’s capacity?
(either related to a specific metric or just generally)**
-



During the assessment of each project, the question answers were grouped into topics. These topics were:

- Project Description Q2
- Specific project performance with respect to metrics:
 - Metric 1, Technology Accessibility Q4
 - Metric 8, Public Acceptance Q4, Q5
 - Metric 9, Political Will Q2, Q4
 - Metric 11b, Potential for Cluster Development Q2, Q4, Q5

A profile for each project or community was derived, based on the project's performance with respect to the metrics 1, 8, 9 and 11b. The profile options were:

- High capacity
- Borderline high capacity
- Borderline low capacity
- Low capacity

The creation of the generic profile involved combining the metric ratings into an overall score. This required assigning a weighting of relative importance to each of the success criteria or capacities.

In evaluating the overall project performance, the following categories were considered:

- Knowledge creation Q3
- Community benefits Q5
- Project realisation Q4
- Overall Q6



4.2 Demonstration project descriptions

PURE Project

The PURE Project is a test and demonstration project on how renewable energy can be used to produce hydrogen in a remote rural location, as a means of local hydrocarbon displacement. The concept of local ownership over hydrogen production for local consumption has been developed jointly by the Unst Partnership and the Aberdeen based company, siGEN. The project will demonstrate how imported hydrocarbons could be progressively displaced by hydrogen produced locally through electrolysis powered by renewable energy. This project, developed on the most northerly island in the UK, can be applied to any remote or isolated community. It pilots an off-grid renewable / hydrogen system.

The Project:

The project will install 2 15 kW wind turbines, electrolyser, hydrogen storage facilities, and a 5 kW hydrogen fuel cell system into 5 industrial units at Hagdale industrial estate on the island of Unst in Shetland. The project has secured financial support from ERDF, Highlands and Islands Enterprise, Shetland Enterprise and Shetland Islands Council. The PURE Project provides evidence of the important role of remote island communities in supporting in innovative ways, the development of the hydrogen economy. It provides a symbol of how the local community can take control over their own energy initiatives. This is the first such community-owned hydrogen project to be established in the UK.

Source: The Hydrogen and Fuel Cell Technology Platform,
<http://infotools.hfpeurope.org/>

Kythnos Island Project

The actions to be implemented in the island of Kythnos will be in saving measures and demand side management schemes to limit the peak power demand and optimize the use of electricity from RES and storage units. Introduction of new RES systems (Solar thermal, PV and Wind mainly) and in the transport sector. The objective would be, by 2008, to limit the energy consumption annual increase from 8% to 4% while the electric energy consumed will be covered by more than 30% from renewables.

Establish in detail a strategy and a monitoring scheme for the implementation of energy saving measures, demand side management, RES/DER introduction and transport sector measures Introduction of energy saving measures by providing subsidies (35%) to energy users on the island (high efficiency lamps, higher efficiency refrigerators, etc.)

(DSM) Demand side management measures:

- Control of deferrable loads
- Ice storage for load shifting
- Solar cooling for load levelling



- Study and implementation of a variable electricity tariff to promote use at low demand and or high RES availability
- Information with a lamp or better with a report unit (display) to all users, possibly through the electric grid. Information concerning when they are encouraged to use electricity and a display of energy consumed per day, instant power consumed etc.

RES2H2 project

Project duration: Dec 2005 – Dec 2006

The production of clean hydrogen from renewable energy sources is, without doubt, an important aspect to be taken into account within the real launching of this gas as an "energy vector" of the future, within a society that is ever-increasing its demand for "sustainable development". We must remember that hydrogen is, or is not, a clean energy source, depending on where it comes from. The objective of RES2H2 is to prove that clean production of hydrogen is feasible on an industrial level, and that the problem of temporary energy storage, usually inherent for many renewable energy sources, can likewise be overcome. Therefore, the integration of renewable energy sources with the recently promoted "hydrogen vector" is what is being addressed in this European project.

Challenges:

The objective of this project is the clean production of hydrogen while exploiting a renewable energy source, such as wind power (although solar energy or biomass could also have been considered), to overcome, on one hand, the problem of storing surplus energy (so frequent with renewable energy sources) and, on the other hand, the production of clean hydrogen that effectively meets the demands of an energy vector that is compatible with sustainable development. From a storage point of view, in order to ensure increasing penetration of technologies related to renewable energies in isolated networks or in decentralized generation, these technologies must be integrated in hybrid systems that permit storage of the energy. The most efficient possibility, and that most respecting the environment, is the integration of renewable energies with hydrogen technology, which permits the production, storage and (subsequent) use of the same to generate electricity.

The effort being made is even greater, given that this Project covers four originally independent projects, all at European level, and at two different locations (Greece and Spain). This integrated project joins hydrogen technologies and wind power, with the latter being a renewable energy source with important seasonal variations in power production. Special attention must also be paid to the design of the accompanying water electrolysis unit. Potable water is considered to be another rare commodity, with an increasing energy cost at national and international level. Its co-production will be researched at one of the two locations (Spain). In summary the project will include the design, construction and assessment of two self-sufficient energy systems, in such a way that wind power can be used to generate hydrogen, electricity and water, with the characteristics of hydrogen as an energy vector being used to this end. These types of systems could be implemented in the more or less near future in any region with a high renewable potential (wind power, for example),



to produce and commercialise hydrogen and to meet the demand for electricity and water (independent water and renewable energy networks).

Project structure:

A total of fourteen partners are participating in the project. Regarding Greece, an electrolyser within the 25 to 100 kW range will be connected to a 500 kW wind charger. The hydrogen thus produced ("green" hydrogen) will be stored in a metallic hydride tank (up to 50 Nm³). It will subsequently be compressed in a series of cylinders in a filling station. This compressed hydrogen can potentially be put on the traditional hydrogen market, as a first step to familiarizing the industrial sector with, and gain confidence in, hydrogen as an energy vector.

Source: The Hydrogen and Fuel Cell Technology Platform,
<http://infotools.hfpeurope.org/>

USEH2backup

Project duration: Dec 2005 – Dec 2006

The project

The USE H2 backup project at Keflavik airport is a demonstration and reliability test on a 5 kW Fuel Cell unit from PlugPower, the unit is called the GenCore unit and is set up as a backup power system for telecommunication systems. Over a one year demonstration period the fuel cells will be turned on and off over 400 times, enabling the project owners to evaluate the potential for using them as an alternative to diesel generators under demanding climatic circumstances. The project is funded by the United States Army Corps of Engineers and the Construction Engineering Research Laboratory and is coordinated by the US company LoganEnergy. They on the other hand hired Icelandic New Energy to handle the necessary communication to the Iceland stakeholders.

The goal

The goal of this joint technological initiative, between Iceland and the US, is to evaluate fuel cells as back-up power for various applications. It is designed to provide better understanding of hydrogen fuel cells and to enable the project owners to exchange experiences. Learning objectives include issues related to installation, service, maintenance, the use and logistics of hydrogen, as well as reliability.

Source: The Hydrogen and Fuel Cell Technology Platform,
<http://infotools.hfpeurope.org/>

Utsira

Project duration: 2002- 2004 (extended to 2008)

The project

Utsira is an island community approximately 18 km west of Haugesund, north of Stavanger.



Given its geographical position and meteorological conditions, it is a unique opportunity to test wind power production. Since the wind turbines installed produce a significant excess of power under optimal conditions, this excess power is to be stored in the form of hydrogen. When it's windy, electrolyzers will produce hydrogen for storage, and when it's calm, a hydrogen engine and a fuel cell will convert the hydrogen back to electricity. The Utsira project is outstanding in that ten households will receive all their electricity from renewable sources in a closed system. The power consumption of the islanders varies, but the stored hydrogen will ensure that sufficient renewable power can be generated at any time, even when consumption is high and wind activity is minimal.

The goal

The aim of the project is to demonstrate an autonomous energy system and integrate established and new technology with renewable energy sources to create a viable renewable energy system.

Source: Norsk Hydro website: <http://www.hydro.com>

GlashusEtt (The Clever Building)

Project duration: 2001- 2005

The project

The “Clever Building” project demonstrates and evaluates a building equipped with a renewable energy system with photovoltaics, electrolyser, hydrogen storage, fuel cell system with biogas reforming, heat recovery system and a control system. The “Clever Building” is the environmental information centre of Hammarby Sjöstad and plays an important role in advertising environmentally-friendly technologies

The goal

The aim of the project is to demonstrate the use of a fuel cell for combined heat and power generation within a building using biogas as a fuel.

Source:

http://www.hammarbysjostad.se/frameset.asp?target=inenglish/inenglish_glashusett.asp

Clean Energy Partnership- Berlin

Project duration: 2002- ongoing

The project

The Berlin hydrogen demonstration project consists of the hydrogen infrastructure of two hydrogen filling stations, the vehicle fleet, a hydrogen information centre and a service station for hydrogen vehicles. CEP is working with a total of three different hydrogen production methods as well as three different hydrogen propulsion systems.

The goal



The objectives of this demonstration project are: to prove the reliability of hydrogen in everyday mobile operation and to ascertain the levels of customer acceptance.

Source: <http://www.cep-berlin.de/>

H2 MUC (Hydrogen Project at Munich Airport)

Project duration: 1997- ongoing

The project

The system comprises two parallel hydrogen supply paths, one for the refuelling of three apron buses with ICE H₂-engines with gaseous hydrogen (GH₂), and one for the refuelling of passenger cars with liquid hydrogen (LH₂). Gaseous hydrogen is produced autonomously on-site using high pressure electrolysis. Liquid hydrogen is delivered in trailers from a nearby liquefaction plant and is stored in the LH₂-storage tank of the station. Refuelling of passenger cars with liquid hydrogen is done fully automatic with a specially developed refuelling robot.

The goal

The main aims of the project are application of hydrogen and investigation of the cost-effectiveness of hydrogen.

Source: http://www.ieahia.org/pdfs/munich_airport.pdf

ECTOS (HyFleet: Cute project)

Project duration: 2001- 2005

The project

A hydrogen production, compression, storage and dispensing station was inaugurated in 2003. Three fuel cell buses of the type CITARO were test driven within the public transportation system of Reykjavik. In January 2006 it was decided to prolong the Hydrogen bus demonstration using the same buses, the same fuel cells, same hydrogen station, but partially with a new agenda. The ECTOS project, therefore, became part of the HyFLEET: CUTE project.

The goal

To demonstrate the state-of-the-art hydrogen technology, by running part of the public transport system with fuel cell busses within Reykjavik, Iceland.

Source: <http://www.ectos.is/en/projects/finished%5Fprojects/ectos/>

Tees Valley region

Project duration: 2006- 2010

The project



Various activities for the production and use of hydrogen are undergoing in the region:

- Several wind farms are in operation, with others going through the planning approval process. Up to 400 MW planned
- A coal gasification plant will capture 5 million tonnes/year of CO₂ and provide an outlet for additional CO₂ point sources. The £500million Middlehaven development will deliver at least 50% CO₂ reduction, but is aiming for carbon neutrality via a modern approach to building design and construction.
- The UK's largest biomass power plant is under construction here, and the world's largest biodiesel production facility has started up.

All these provide impressive supply chain facilities for additional related sustainable energy projects.

The goal

The Tees Valley Hydrogen project covers a number of projects whose aim is to promote the Tees Valley as a centre for renewable and new energy source systems in the UK.

Source: <http://www.renewteesvalley.co.uk>

Hydrogen, Energy, Environment and Transport Platform

Project duration: 2004- ongoing

The project

The creation of a hydrogen platform in the French region of Nord Pas de Calais has the ambition to positioning the region on an emergent technology, namely the use of hydrogen in internal combustion engines. This technology is supposed to enable the transition towards a full "hydrogen economy". The research topics explored by the HEET platform include:

- Conversion of engines to hydrogen
- Development of hydrogen in transport
- Deployment of the hydrogen economy

The goal

The HEET platform aims at coordinating the efforts of companies and research centres already engaged in this technology, at promoting their actions, while taking part in European and national programmes.

Source: <http://www.h2-developpement.fr>



4.3 List of conducted phone interviews with demonstration projects

Table 5: List of conducted phone interviews with demonstration projects

Country	Respondent	Project
Iceland	N/A	USEH2Backup
United Kingdom	Sandy Macaulay	PURE Project
Spain	Salvador Suárez García	RES2H2
Greece	Stathis Tselepis	Kythnos Island Project
Norway	Elisabet Fjermestad Hagen	Utsira
Sweden		GlashusEtt
Germany	Henning Niemeyer	CEP-Berlin
Germany	Judit Mielert	H2MUC
-	N/A	Ectos (HyFleet: Cute project)
United Kingdom	Mr. Dermot Roddy	Tees Valley Region
France	Mme. Helene Vauchez	Nord Pas de Calais