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**Lombardia & Rhein-Main towards Zero Emission:  
Development and Demonstration of Infrastructure Systems for Hydrogen as an  
Alternative Motor Fuel**

Instrument                      Integrated Project  
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## **D7.2: Work plan acceptance**

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<b>PP</b>	Restricted to other programme participants (including the Commission Services)	
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<b>CO</b>	Confidential, only for members of the consortium (including the Commission Services)	

## **Executive summary**

The purpose of this work plan is to outline the next four years of research to evaluate acceptance problems relating to the technologies demonstrated in the Zero Regio project.

The research approach is exploratory and actor-oriented. It aims to understand and assess:

- Potential acceptance problems in all parts of the fuel chain.
- Character of acceptance problems? Are they pure perception / public-relations problems? Or is there a core of technological risks or other negative effects that needs to be addressed?
- Interested parties and their role in relation to acceptance. Coverage: The general public, neighbours, interest groups, media, and decision makers.
- Transmission of acceptance problems between these different parties.
- Experience from similar technologies and/or risks scenarios, and the relevance of this experience.

The research tools are mainly qualitative, allowing in-depth study of acceptance problems and their causation and interrelations. Quantitative tools will be used only if qualitative tools have led to the identification of important acceptance problems in a given group of actors and only if this group is sufficiently large and homogeneous to achieve valid results by quantitative tools.

The research aims to get maximum knowledge from the demonstration itself. Therefore, as far as possible, the work is scheduled to be concurrent with the demonstration activities, rather than predating them.

Knowledge from the research will be used for considerations on strategy and policy development, emphasising how the obtained research results can be used to choose directions and define priorities.

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## **Preface**

The Zero Regio project is a demonstration of hydrogen infrastructures and a small number of hydrogen-fuelled cars on the streets of Mantova (Italy) and in the airport of Frankfurt am Main (Germany). It is part of a larger effort by the EU to demonstrate hydrogen technology, for reasons of energy security and environmental protection.

Information concerning the Zero Regio project can be found at <http://www.zeroregio.com>, while more general information concerning EU hydrogen policies and activities is found at the web sites of the European Commission<sup>1</sup> and the European Hydrogen and Fuel Cell Technology Platform.<sup>2</sup>

This work plan is a contractual requirement in the Zero Regio project, defined as deliverable D7.2 and due after the first year of the project. The purpose is to outline the research to be done in the remaining four project years to improve understanding of the acceptance of hydrogen technologies.

2005-11-14  
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<sup>1</sup> [http://europa.eu.int/comm/research/energy/nn/nn\\_rt/nn\\_rt\\_hy/article\\_1142\\_en.htm](http://europa.eu.int/comm/research/energy/nn/nn_rt/nn_rt_hy/article_1142_en.htm)

<sup>2</sup> <https://www.hfpeurope.org>

## **Reaching beyond the "fear of hydrogen" hypothesis**

*"A belief among many experts persists that the wider public would not accept hydrogen fuel for safety reasons". This is an opening statement of the AcceptH2 report<sup>3</sup>, published summer 2005, based on hydrogen bus demonstrations in the cities of London, Berlin, Luxembourg, Perth and Oakland. The reasons cited for this belief would be "associations with the Hindenburg, hydrogen bomb or other explosive connotation."*

This pessimistic belief was completely refuted by the AcceptH2 study. The public was shown to be remarkably positive towards hydrogen as fuel. Even before the demonstrations, only 3% of respondents were negative even towards a large-scale introduction of hydrogen busses. Close to half were unconditionally positive. After the demonstration, unconditional support rose to 67%.<sup>4</sup> Prior studies had reached similar conclusions, but on a more narrow empirical basis.

This is an important starting point for acceptance research in the Zero Regio project. The "fear of hydrogen" hypothesis was definitively buried by the AcceptH2 report. It is not a meaningful research task to bury it once more. To be scientifically productive, acceptance research has to pass beyond this hypothesis.

Fortunately, the Zero Regio consortium already did so in its 2003 proposal<sup>5</sup>. The tasks, confirmed in more summary form in the contract, are indeed pointing towards a new stage of research, which is about a differentiated and complex understanding of acceptance, rather than a simple measurement.

The problem with simple measurements is that they don't really say much about the future, and are not very helpful for strategy. What can you do with a high acceptance rate, except sleep better at night? And should you really sleep better? Nuclear power once had a high acceptance rate. So did tobacco. No doubt, back in the 1950's, the signs of impending trouble were already there. They would not be evident with standard opinion polls, however, only with careful qualitative analysis.

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<sup>3</sup> Tanya O'Garra (2005) AcceptH2 Full Analysis Report - Comparative Analysis of the Impact of the Hydrogen Bus Trials on Public Awareness, Attitudes and Preferences: a Comparative Study of Four Cities. London: Imperial College. Quotations from pp 9 & 73. Report available at <http://www.accepth2.com>

<sup>4</sup> This degree of unconditional support is so high, that it might even be cause for worry. After all, unconditional support for large-scale introduction is a rather naïve position, considering the large remaining uncertainties about hydrogen technology, particularly costs and environmental impact. So, rather than being burdened by primitive fears (hydrogen bombs, Hindenburg, etc.), hydrogen may in fact be burdened by too easy acceptance. This should be understood as a burden, because naïve acceptance can very easily turn into disappointment or disillusion.

<sup>5</sup> The proposal had a specific work package for acceptance research, which in the contract was merged into a more comprehensive socio-economic work package, with less specification of the task.

The objective of acceptance research was defined as: "assess acceptance problems and propose mitigation strategies".

The specific tasks were:

*Task 1: Identification of potential acceptance problems in all parts of the fuel chain.*

*Task 2: Analysis of acceptance problems? Are they pure perception problems? Or is there a core of technological risks or other negative effects that needs to be addressed?*

*Task 3: Identification of interested parties and analysis of their role in relation to acceptance. Coverage: The general public, neighbours, interest groups, media, and decision makers.*

*Task 4: Analysis of the transmission of acceptance problems between these different parties.*

*Task 5: Assessment of experience from other production facilities that have somewhat similar technology and risks.*

*Task 6: Comparison between regions: Do they have much the same acceptance problems? Or do they differ significantly? How may this be relevant for development of implementation strategies?*

## **Defining research aims**

The Zero Regio approach, as laid out in the proposal and the contract, is an exploratory approach, aiming to identify and understand acceptance problems in all parts of the actor network, and not only or primarily at the public opinion level. If public opinion is overwhelmingly positive, as indicated by the AcceptH2 results, there is good reason to focus on acceptance problems emerging from other sides and potentially able also to influence public opinion.

In the words of the contract: "*The penetration of new technologies depends strongly on acceptance, by citizens in general as well as key actors. Interested and affected parties and their potential acceptance problems with the complete fuel chain (well to wheel) will be identified. The identified problems will be analysed as to their origin. The transmission of acceptance between parties will be studied and regional differences will be observed.*"

This was laid out in more detail at the Project Coordination Committee meeting PCC2, 2005-04-28 in Frankfurt, where the following scope of work was proposed and accepted:

- *Potential acceptance problems in all parts of the fuel chain.*
- *Character of acceptance problems? Are they pure perception / public-relations problems? Or is there a core of technological risks or other negative effects that needs to be addressed?*
- *Interested parties and their role in relation to acceptance. Coverage: The general public, neighbours, interest groups, media, and decision makers.*
- *Transmission of acceptance problems between these different parties.*
- *Experience from similar technologies and/or risks scenarios, and the relevance of this experience.*

In fact, this was just a slight restatement of the tasks defined two years earlier in the project proposal.<sup>5</sup>

## **Methodological considerations**

The future of hydrogen is likely to depend of three key factors:

- costs
- acceptance
- perceptions regarding environment and security of energy supply

Acceptance cannot be understood without reference to the two other factors: Costs and perceived threats.

Hydrogen is typically promoted as a problem-solver for societies worried about the security of their energy supplies and/or about the health effects of air pollution. This is a very specific driver for technology development, and in fact not very typical. For instance, the drivers for the DVD or the mobile phone were most importantly the ability to add new dimensions to everyday life with respect to entertainment, freedom of movement and ease of social contact, and consequently their enthusiastic reception by individual consumers. Hydrogen, on the other hand, basically carries the promise, that we can continue living as we have always done, driving our cars and breathing our air. These qualities of our life are now perceived as threatened, and hydrogen promises to alleviate this threat. As a technology driver, this is more reminiscent of the quest to develop vaccines or antibiotics or even to the drivers for development of weapons technology.

Threats can enormously influence acceptance. Taxpayers have been willing to put huge amounts of money into the development of nuclear weapons, in spite of the fact that this is obviously a very dangerous technology. Laboratories for disease identification and vaccine production also work with highly dangerous technologies, but are well accepted (if not by neighbours then at least by the rest of the population). This can be compared with the non-acceptance of sister technologies like nuclear power or genetically modified organisms (GMOs) that would appear to be less dangerous.

Threats are also fickle, however. Oil crises have come and gone. Environmental problems suddenly get focus, and are then halfway forgotten after some years. Therefore, acceptance can also wax and wane, if it is dependent on certain perceptions of threats. This can create significant problems for businesses that engage in a field, where development is driven by social problems like energy security or environmental pollution.<sup>6</sup>

Thus, it is important to know not only if people accept hydrogen technologies, but also why they do so. If acceptance is contingent on perceptions of threats, it may not be stable. If it is independent of such perceptions, it is probably more solid.

Costs are important, because the key acceptance problem may well be the willingness of citizens to pay the costs of hydrogen technology, either as car drivers or as taxpayers. Of course, if the alternative is to stop the cars, the willingness to pay for a solution may be quite high. But there are other solutions that may be less perfect, but cheaper. Energy security can be enhanced by use of bio-fuels or natural gas. Coal or oil shale can be used to make synthetic fuels. Even electric cars could have a renaissance. The automobile industry has already made cars much cleaner than before, and can surely achieve additional progress without a conversion to hydrogen. Urban transit systems can also be used to relieve congestion and pollution in cities. So even if citizens feel threatened by energy security problems and urban air pollution, their acceptance of hydrogen may be contingent on costs.

The acceptance by citizens is a major influence on acceptance by other actors. Carmakers are obviously eager to accept a new technology, if they believe it will sell well. If the market proves to be uncertain or too narrow, their acceptance may also vaporise. Regulators will not want to be in conflict with citizens, so if citizens are clear in their acceptance of hydrogen, regulators are likely to cooperate with industry to remove unnecessary obstacles. On the other hand, if significant groups of citizens have hostile attitudes, the regulatory process can grind to a halt, as seen for GMOs or nuclear power. Citizens themselves are influenced by other actors. If hydrogen is well promoted by the car industry, citizens will listen. If regulators send a clear message about safety, citizens will also listen. Acceptance is thus created (or lost) in a complex interaction between several parties.

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<sup>6</sup> The AcceptH2 project found a large rise in hydrogen acceptance in just a single year. This was not possible to explain from any of the parameters they had measured. This kind of result is pleasant enough for hydrogen proponents when the trend is upwards. But if acceptance can rise without a known explanation, it can probably as easily fall without a known explanation. It may simply be volatile. Or it may be contingent on factors quite outside the influence of hydrogen proponents, such as the state of affairs in the Middle East.

## **Choosing appropriate research tools**

The principal tools for the acceptance study are qualitative research tools, allowing in-depth study of acceptance problems and their causation and interrelations. The most important tool will be in-depth interviews with actors, usually conducted on-site. In cases where a discussion between actors is likely to be more productive than person-to-person interviews, these may be replaced or supplemented by group-based tools. Another important qualitative tool will be literature studies, covering prior hydrogen acceptance research as well as acceptance research from other areas that have traits in common with the build-up of the hydrogen economy. Quantitative tools, such as standardised surveys, will be used only if qualitative tools have led to the identification of important acceptance problems in a given group of actors and only if this group is sufficiently large and homogeneous to achieve valid results by quantitative tools. To overcome language barriers, local assistants will be employed as needed, either as translators or to perform supervised research tasks. Cooperation will be established with local partners, when this can help overcome barriers or increase the depth and scope of the research.<sup>7</sup>

## **Orientation towards actors**

The acceptance study shall orient itself towards actors and their different perspectives. In-depth interviews or focus group studies will be made with all major types of actors, as indicated in table 1 below. For each actor, acceptance problems will be described and evaluated. A comparison will be made with the actors acceptance of competing hydrogen technologies (if relevant) and conventional fuels.

The priority of different actors will not be pre-determined, but will be established dynamically, in response to research findings. If significant acceptance problems are identified for a specific type of actor, this type of actor will get priority attention. If no significant acceptance problems are found in preliminary investigations concerning a specific type of actor, this will result in reduced priority or termination of further work.

The interaction between actors will need to be highlighted. For instance, car owners may respond negatively, if maintenance staff does not fully accept hydrogen vehicles. The general public may respond negatively if drivers don't like the cars. Insurance companies may respond negatively if regulatory authorities waver in their response. On the other hand, an enthusiastic reception by the general public may well have significant influence on other actors. This is obvious for car manufacturer, for whom this will indicate a market opportunity, but the influence could well extend even to those actors that are supposed to be "objective" in their acceptance, such as regulators or insurance companies.

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<sup>7</sup> As example, informal discussions have been initiated with LABTER in Mantova concerning their integration of hydrogen issues in future work with high-school students and teachers. Potentially, this could create an important platform for the identification and study of local acceptance problems, allowing an outreach into the local population that could not be achieved without such cooperation. As part of the exploration of such options, a classroom session was arranged on 2005-10-14, in order to confront local high-school students concerning environmental issues. Further discussion of the idea has been deferred to the 2nd quarter of 2006, as it has to fit with school planning for 2006/07.

**Table 1: Orientation towards actors**

		Description and evaluation of acceptance problems	Comparison with other hydrogen sources and conventional fuels
Refuelling stations, including on-site hydrogen production	<i>Acceptance problems observed among:</i>		
	Company management		
	Company staff		
	Owners of other refuelling stations		
	Neighbours		
	Other members of local community		
	General public		
	Users of refuelling station		
	- hydrogen users		
	- other users		
	Public authorities		
	- specify		
	Insurance companies		
	Investors and financial institutions		
Off-site hydrogen production	<i>Acceptance problems observed among:</i>		
	Company management		
	Company staff		
	Neighbours		
	Other members of local community		
	General public		
	Public authorities		
	- specify		
	Insurance companies		
	Investors and financial institutions		
	Costumers		
	General public		
Vehicles	<i>Acceptance problems observed among:</i>		
	Car manufacturers		
	Car owners		
	Maintenance staff		
	Drivers		
	Passengers		
	General public		
	Public authorities		
	- specify		
	Insurance companies		

## **Scheduling the work**

The acceptance studies do not exist apart from the demonstration, but should be understood as narrowly integrated with the demonstration. Just as the demonstration creates a situation, where technology meets the test of real life, it also creates a situation where acceptance meets the test of reality. At the level of technology, a demonstration is very useful for bringing out the weak sides and the unexpected problems of a new technology. The same is true at the level of socio-economics, in casu acceptance. It is easy to love or hate something that does not yet exist. Acceptance is tested in a more serious way by a demonstration, than by questions about a hypothetical situation. For acceptance, just as for technology, a demonstration is an instrument to bring weak sides and unexpected problems out in the open.

Therefore, Zero Regio resources for acceptance research should be focused effectively on the demonstration phase, and not be wasted early on by too much desk research or too many questions that remain hypothetical. The demonstration itself will create a much more valuable research material. It would be bad planning, if a large part of the research resources were expended before research becomes really interesting.

Even the planning should not happen too quickly. Much of the practical project implementation remains somewhat vague, even one year after the start of the project. This is particularly true for the vehicle part, which provides the most important interface with citizens. For instance, it is not really known yet, who will drive the vehicles, for what purposes, with which passengers, etc. Issues like permissions and insurance for vehicles have not progressed very far either. Research planning has to depend on the practical layout of the demonstration.<sup>8</sup>

Accordingly, the foreseen development schedule for acceptance research is outlined in table 2, see next page.

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<sup>8</sup> A small example as illustration: The options to study acceptance among insurance companies depends on the way insurance is bought. If a significant number of companies are asked for a quote, and their offers are compared, there will be an empirical basis for going back to insurance companies and ask: *Why would you not give a quote? Why was your price so high? Would you offer the same price, if this was not a demonstration, but 100 000 vehicles?* On the other hand, if the car owners do not ask around, but go directly to their usual insurance partner, it is doubtful whether the demonstration will produce results that can be used to assess acceptance. If the insurance company was asked about their reasoning, they might well answer: *Well, this was not really about hydrogen, but about an important business relationship. The car owner is a million-€ client for us. When he asks for insurance for 2-3 hydrogen cars, we are there to help him, of course. Our offer is not based on an assessment of hydrogen, but on an assessment of our relationship with this client.* In this latter case, further research would be rather meaningless. The demonstration would not have created a real-life situation allowing meaningful acceptance research.

**Table 2: Principal work schedule**

	Tasks	Approximate share of resources
Month 1-12	Getting familiar with the project technology and the partners. Acceptance research recommendations as input to general project planning <sup>9</sup> Establishing overview of literature. Contributing to construction of assessment framework	10%
Month 12	Deliverable D7.2: Work plan acceptance (The present document)	
Month 13-24	Acceptance research recommendations as input to general project planning. Developing local research partnerships. In-depth study of literature. Actor-based studies of acceptance problems encountered in the implementation of infrastructures. Adapting research plan to experience from implementation of infrastructures and the planning of the vehicle demonstration.	10%
Month 24	Deliverable Dx.x: Report on problems of acceptance, analysed prior to vehicle demonstration.	
Month 25-36	Main phase of acceptance studies that are independent of vehicle demonstration.	30%
Month 36	Deliverable Dx.x: Report on acceptance observations concerning infrastructures	
Month 37-60	Main phase of acceptance studies concerning vehicle demonstration. Synthesis of infrastructure and vehicle research. Analysis of regional differences. Conclusions	50%
Month 60	Deliverable dx.x: Final report on acceptance.	

<sup>9</sup> In order to secure a demonstration layout that maximise the options for acceptance studies.

### **Taking account of local differences**

There are considerable differences between the two demonstrations in Frankfurt and Mantova. Activities in Mantova take the vehicles much further out into the society than do activities in Frankfurt. The vehicles in Mantova will be driven on ordinary streets, will be seen everywhere in town and surroundings, and will be used for a multitude of purposes, involving many users and passengers. On the other hand, in Frankfurt, the demonstration will take place mainly inside the fences of the airport, will be more remote from the public, and will probably involve a more exclusive set of users. Certain more subtle institutional differences point in the same direction. For instance, the cars in Frankfurt remain the property of the car manufacturer, so there is no interaction between owner and producer. Whereas in Mantova, there is an owner on one side and a car producer on the other side, obviously a closer approximation to real life, allowing somewhat more realistic acceptance studies.

In the general public, the difference in perception of the two demonstrations is likely to be even more pronounced than the differences in the set-up itself. The AcceptH2 study<sup>10</sup> showed a remarkable difference in demonstration awareness between the large city of London, and the smaller cities of Luxembourg and Perth, with Berlin in-between. Whereas 51 % of citizens<sup>11</sup> in Luxembourg were aware of the demonstration, only 20 % knew of it in London. This is easy to understand, as a few busses are more visible in Luxembourg than in London. This physical visibility effect may well be amplified by a media effect, as local events have more difficulty overcoming the media barrier in a large city.

Thus, as far as acceptance is concerned, there will probably be more to study and learn in Mantova than in Frankfurt, especially as far as the general public is concerned, but also in some other respects. If this proves true, it should be reflected in the research activity, as resources may be more effectively employed in Mantova than in Frankfurt. A reasonable hypothesis may be that 2/3 of resources should be used in Mantova and 1/3 in Frankfurt. This should be taken only as a hypothesis. If the demonstration in Frankfurt becomes more open than expected, resources may need to be shifted. This may also be the case if acceptance problems turn out to be more intense or otherwise more interesting in Frankfurt, than in Mantova.

It could also be argued, that research should be done differently in the two locations. Possibly, Mantova should be used as the primary site for development of observations and hypotheses, whereas Frankfurt should be used as testing ground for hypotheses developed from the Mantova experience. If this idea is adopted, the work in Frankfurt should be delayed somewhat and the work in Mantova speeded up. In this case, the table above should be understood as a kind of average that would need spatial differentiation in the further research planning.

It should be emphasised, that these are considerations in a very early stage. The situation in Frankfurt has not yet been studied nearly as closely as the situation in Mantova. This may give a false bias.

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<sup>10</sup> Tanya O'Garra, op.cit, pp 28-31.

<sup>11</sup> First time respondents to random telephone interview.

## **Supporting strategy and policy development**

Acceptance research supports the development of strategies and policies, both at the actor level and at the societal level. It does so mainly by helping to focus attention and resources on a few proven and important problems, rather than a multitude of imaginary or marginal problems. This is essential for development of strategies and policies, as these are rarely effective without strong focus and clear priorities.

By choosing a qualitative and analytical approach, Zero Regio acceptance research also aims to provide a certain level of foresight, by enabling a distinction between emerging problems that are likely to be stumble-blocks for the future, and passing problems that may require a lot of momentary attention but would tend to guide strategy in false directions.

Mostly, acceptance research cannot define solutions, as they typically need to be found in other realms of knowledge. To take a well-known and simple example, acceptance research is likely to find that a restricted driving range for hydrogen vehicles would have significant negative consequences for acceptance by owners.<sup>12</sup> Such a result helps decision-makers focus on the importance of achieving a good driving range. However, it cannot tell how to solve this problem. That is a matter for technicians. Even then, acceptance research is not completely impotent as far as solutions are concerned. One needs just to think of the situation that would arise if technicians were unable to solve the driving range problem. Then it becomes very important to have a precise understanding of the acceptance problem. Are people worried about the increased uncertainty of refuelling, due to the limited range? Then a second-best strategy might be the creation of a very tight network of refuelling stations. Or are people worried about the inconvenience of frequent refuelling? Then a second-best strategy might be to surpass the service quality of conventional refuelling stations (i.e. easier access, quicker refuelling, automatic debit) or even to develop alternatives to the very concept of refuelling stations (refuelling at home or at parking lots). Again, acceptance research cannot define the solutions, but it can help rank proposed solutions into those that are more likely to solve or circumvent the acceptance problem, and those that are less likely to do so.

A part of the Zero Regio final report on acceptance shall be devoted to strategy and policy development, outlining how the obtained research results can (and cannot) be used to give directions and define priorities.

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<sup>12</sup> This has been found repeatedly in electric vehicle acceptance research.