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STAKEHOLDER FEEDBACK ON MATISSE SUSTAINABLE HYDROGEN VISIONS AND PATHWAYS:
Findings from the June 2007 Hydrogen Stakeholder Workshop

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MATISSE Methods and Tools for Integrated Sustainability Assessment

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MATISSE (Methods and Tools for Integrated Sustainability Assessment) aims to achieve a step-wise advance in the science and application of Integrated Sustainability Assessment (ISA) of EU policies. In order to reach this objective the core activity of the MATISSE project is to improve the tools available for conducting Integrated Sustainability Assessments.

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The MATISSE Working Papers can be downloaded at www.matisse-project.net

Preface

About the MATISSE project

The MATISSE (Methods and Tools for Integrated Sustainability Assessment) project is funded by the European Commission, DG Research, within the 6th Framework Programme. The project is interested in the role that Integrated Sustainability Assessment (ISA) could play in the process of developing and implementing policies capable of addressing persistent problems of unsustainable development and supporting transitions to a more sustainable future in Europe. The core activity of MATISSE is to develop, test and demonstrate new and improved methods and tools for conducting ISA.

This work is carried out through developing and applying a conceptual framework for ISA, looking at the linkages to other sustainability assessment processes, linking existing tools to make them more useable for ISA, developing new tools to address transitions to sustainable development and applying the new and improved tools within an ISA process through a series of case studies.

The extent to which the case studies are carrying out a complete ISA for their area of focus varies between attempts to cover all phases of an ISA process to partial implementation of the process. Equally, different case studies are oriented to developing and testing tools and approaches to some, but not all, of the methodological challenges of ISA. The case studies are complementary, however, and the set of cases offers the opportunity to address a wide range of methodological challenges and to explore linkages between cases. An evaluation of practical experiences with ISA implementation in the case studies will provide guidance on the further improvement of methods and tools. Results will also contribute to more informed policy advice.

What is ISA?

Within the MATISSE project, Integrated Sustainability Assessment (ISA) has been defined as a cyclical, participatory process of scoping, envisioning, experimenting, and learning through which a shared interpretation of sustainability for a specific context is developed and applied in an integrated manner, in order to explore solutions to persistent problems of unsustainable development. ISA is conceptualised as a complement to other forms of sustainability assessment, such as Sustainability Impact Assessment, Integrated Assessment and Regulatory Impact Assessment. Whereas these other forms of assessment fulfil the pragmatic need for *ex ante* screening of incremental sectoral policies that are developed within the prevailing policy regime, ISA is conceptualised as a support to longer-term and more strategic policy processes, where the objective is to explore persistent problems of unsustainable development that have a systemic pathology and possible solutions to these. ISA is therefore oriented toward supporting the development of cross-sectoral policies that specifically address sustainable development and at exploring enabling policy regimes and institutional arrangements.

MATISSE Working Papers

Matisse Working Papers are interim reports of project activities that are published in order to illustrate ongoing work and some provisional conclusions, as well as providing the opportunity for discussion of the approaches taken by the project and interim results. This discussion should be both within the project and between project members and the broader scientific and policy communities. Readers are encouraged to contact the authors to discuss the content of MATISSE Working Papers.

Jill Jäger and Paul Weaver

Editors of the MATISSE Working Paper Series

ABSTRACT

The stakeholder workshop discussed here is part of an iterative process of consultation and social learning with stakeholder groups in conducting Integrated Sustainability Assessments (ISAs) of sustainable hydrogen and mobility within the MATISSE project. Break-out discussion groups and self-completion questionnaires were used to elicit stakeholders' feedback on, and further input to, the hydrogen and mobility transition modelling work conducted within MATISSE, to identify whether sustainability visions should be modified and which policies should be assessed, and to foster social learning amongst stakeholders. In respect of the vision of sustainable hydrogen-based transport developed in MATISSE, stakeholders agreed that different countries should use different feedstocks and production technologies, and most agreed that it will be necessary to use conventional hydrogen production methods in the initial phase of a hydrogen transition, before (rapidly) moving towards a renewable-based transport system. Overall, the questionnaire results show stakeholders are ambivalent about the social and economic impacts of hydrogen-based transport, but are optimistic about its environmental impact. Furthermore, the group discussions revealed concerns that a hydrogen transition may imply a move towards more unsustainable transport in some respects, namely increasing social inequality and problematic technologies (i.e. carbon capture and sequestration [CCS] and nuclear) involved in hydrogen production, and contributing to unsustainable economic, energy and transport growth. These concerns about the possible unsustainability of hydrogen suggest these issues would be usefully addressed in policy assessments of hydrogen. Indeed, most participants advocated an alternative sustainable transport vision – most commonly, a 'modal shift' vision – to be considered in addition to a hydrogen-based transport vision. Alternative transport technologies (biofuels, hybrid-electrics) and reduced mobility demand were also discussed, though there was less agreement about the merits of these alternatives. Overall, stakeholders at this workshop were very optimistic about the role of transport technologies – particularly hydrogen – in tackling problems of unsustainability. In respect of particular policies that should be assessed, stakeholders particularly favoured economic measures, such as carbon/emissions taxes, and research, development and demonstration (RD&D) to promote novel technologies. Investment in public transport infrastructure, public education, and institutional changes (e.g., to avoid global inequalities, to develop locally relevant solutions) were also suggested for promoting sustainable transport. Around a third of stakeholders said they had changed their views as a result of participation in the break-out groups; and most said they had learnt something.

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1 Introduction

As part of a cluster workshop on sustainability of hydrogen and biofuel transport technologies held in Frankfurt on 15th June 2007, MATISSE researchers conducted break-out discussion groups with, and distributed self-completion questionnaires to, transport stakeholders. As part of the workshop, individuals from WP7 and WP9 also presented their findings from the hydrogen and mobility transition modelling and the stakeholder work to date. The workshop presentations and stakeholder questions posed in these break-out groups and questionnaires built on the findings from the previous stakeholder cluster workshop, conducted in February 2006 (see Whitmarsh et al., 2006), and modelling work conducted in the interim.

The aims of the June 2007 break-out groups and questionnaires were:

- To elicit feedback from stakeholders on the appropriateness of the visions and pathways developed in WP7.1 and WP9;
- To elicit feedback from stakeholders on the sustainability implications of the modelling results;
- To elicit views on the relative contributions and drawbacks of hydrogen, biofuels and other alternatives in fostering sustainable mobility;
- To elicit stakeholders' views about the usefulness of the modelling tools and findings for policy assessment;
- To feed stakeholders' views and needs into the ISA planning processes and tool development in WP7.1 and WP9;
- To foster social learning, through group discussion, amongst both stakeholders and researchers.

Participants at the cluster workshop included researchers and consultants, policy-makers, and members of the automotive and energy industries from across Europe, with interests in transport technologies. While this does not represent a comprehensive range of transport stakeholders, it includes key decision-makers for the issue. Further recent work has focussed on eliciting the views of transport users and other stakeholders (see Whitmarsh, 2007).

All workshop participants (N=32) were assigned to one of four break-out groups according to the stakeholder 'category' they represented (i.e. Automotive Industry, Energy Industry, Research, Consultancy, NGO, and Policy) and gender. The composition of the break-out groups was designated in advance of the workshop.

The break-out groups comprised both heterogeneous and homogeneous categories of stakeholders.

- Group 1 was a homogeneous group of 8 Research stakeholders only (7 men, 1 woman; female facilitator);
- Group 2 was a homogeneous group of 8 Research stakeholders only (6 men, 2 women; female facilitator)
- Group 3 was a heterogeneous group comprising 3 research, 1 consultancy, 1 policy, 1 energy industry, and 2 automotive industry (6 men, 2 women; female facilitator)

- Group 4 was a heterogeneous group comprising 2 research, 2 policy, 2 automotive industry, and 2 energy industry (8 men; male facilitator)

The rationale for using both homogeneous and heterogeneous groups was to enable a comparison of group dynamics and social learning amongst similar and diverse stakeholder groups.

Each group was facilitated by one facilitator from the MATISSE project team. Facilitators took extensive notes during the break-out sessions and used flip-charts to record the key points of the discussion. The questions used to guide discussion in the break-out groups (Appendix 1) were circulated to participants at the start of the workshop.

At the end of the break-out group discussion, participants were asked to fill in a brief self-completion questionnaire with more focussed questions that allow respondents to express their opinions anonymously. This questionnaire also provided an indication of social learning amongst group participants. (Appendix 2 shows the self-completion questionnaire). In total, 24 questionnaires were returned completed.

The rationale for using both group discussion and individual self-completion questionnaires is that there are advantages and limitations to each method. Combining these methods thus provides a complementary strategy for knowledge elicitation and social learning.

This paper reports on the main findings from the break-out group discussions and questionnaires. Sections 2 to 5 report on the main findings relating to ‘content’, namely stakeholders’ roles and interests in hydrogen transport, their feedback on the hydrogen visions and modelling results, their views on the relative roles of hydrogen and biofuels in sustainable transport, and their perspectives on policies for sustainable hydrogen, biofuels and mobility. Section 6 describes our analysis of the ‘process’ itself, including evidence of social learning. Section 7 draws together the findings and presents key conclusions.

2 Stakeholders’ roles and interests in transport

As indicated in Figure 1, most of the stakeholders – 20 of 24 – who took part in the break-out groups stated that they work in Academia. Two participants said they work in the Energy Industry, 1 in Government, and 1 in the Automotive Industry. (NB - there are minor disparities here between the stakeholder categories defined in advance for participants and summarised above, and those identified by stakeholders themselves as indicated in the questionnaire responses). This is a higher proportion of researchers than attended the previous stakeholder workshop (under half were researchers; Whitmarsh et al., 2006).

In keeping with the greater proportion of Research stakeholders represented in the break-out groups, the most popular response to the question of organisational goals was ‘research’ (see Table 1). Almost half the participants mentioned ‘sustainability’ as an aspect of their organisational goals relating to transport. Consistent with the previous workshop, when asked explicitly how important sustainability concerns are to their organisation’s goals and decision-making, virtually all (22 of 24) stakeholders said it is either very or quite important (Figure 2).

Figure 1. Which of the following best describes the organisation you work for?

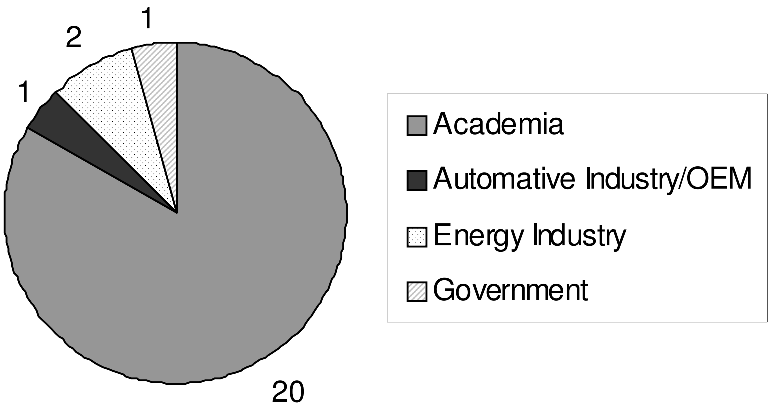
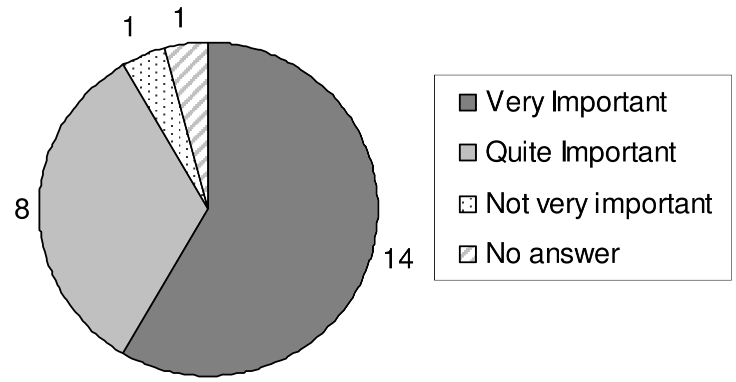


Table 1. What are your/your organisation's goals vis a vis transport?

Research - transport, transitions, energy, environment, consumer preferences, economics	16
Sustainability	10
Policy consulting	2
Development of transport policy	1
Supply fossil fuels	1
Transport planning	1
Provide individual mobility	1
N/A, no answer	2

Figure 2. How important are considerations of 'sustainability' to your organisation's goals and decision-making for transport?



3 *Stakeholders' feedback on the hydrogen transition visions, pathways and modelling results*

Two questions posed to stakeholders addressed *assumptions* used in the MATISSE hydrogen transition modelling work: namely, that hydrogen production methods and feedstocks could differ between European countries or regions, and that conventional hydrogen production methods should be used during the initial stage of a hydrogen transition; results from these two questions are given in sections 3.1 and 3.2, respectively. Stakeholders were also asked about the sustainability implications of the modelling results presented at the workshop (by MATISSE researchers and others; see section 3.3), whether alternative visions should be considered (see 3.4), and about the usefulness of the modelling results for policy assessment (see 3.5).

3.1 Differentiating hydrogen production technologies and feedstocks by regions

Overall, stakeholders agreed that using different hydrogen technologies in different areas makes sense. In fact, the highest agreement (22 out of 24 respondents) with any of the attitude statements in the questionnaire was in response to the statement 'The choice of H2 feedstocks and production technologies should be different within each European country' (see Table 2 and Appendix 3).

For break-out Groups 1 and 2, it was clear that this approach was necessary to make use of the resources and technologies available in each region, and because of their different history and social attitudes. For example, Group 1 pointed out that trying to implement new energy technologies could create social acceptance problems for hydrogen (e.g., if using nuclear in Germany, coal in France, etc.). Participants in Groups 1 and 3 also pointed out that regional variation in availability of renewables need to be considered: e.g., crops in Central and Eastern Europe, wind in the North Sea, solar in southern Europe. Group 4 also mentioned that Carbon Capture and Storage (CCS) depend on availability of suitable geological formations, and also pointed to the very different potentials for renewables in each country. They argued that another constraining factor is R&D support tied into specific technologies. This group made the point that considering hydrogen feedstocks is much the same as considering feedstocks for the electricity sector (where different technologies dominate in different countries).

For Groups 2 and 3, this approach was important to ensure diversification of energy sources. Group 3 similarly agreed – unanimously – that diversification was crucial; in fact one participant felt this was the most important sustainability criterion for hydrogen. Another felt technological diversity is key for economic growth, remarking that the economy would collapse if all technological possibilities were not explored. Group 1 indicated that the ability to use a diversity of feedstocks was in fact one of the main advantages of using hydrogen, despite the fact that there are attractive alternatives and that major efforts are still needed to improve storage and fuel cell technologies.

Group 2, on the other hand, also suggested that this strategy could be an important process of trying out different technologies to see which one is the best. Group 1, similarly, pointed out that the EU visions for transport and hydrogen are clearly pushing towards renewables, suggesting there will be some degree of convergence in feedstocks across regions.

Group 4 participants suggested an agreement on CO2 reductions might have an indirect effect on technology, as it would limit options for feedstocks. Consequently, they supported an open and flexible approach in the face of an uncertain future; like Group 2, they felt this strategy could facilitate learning about the most appropriate long-term energy mix.

Table 2. Stakeholders' attitudes to hydrogen technologies

Attitude Statement	Agree strongly (5)	Agree (4)	Neither agree nor disagree (3)	Disagree (2)	Disagree strongly (1)	Mean	SD
The choice of H_2 feedstocks & production technologies should be different within each European country	10	12	0	2	0	**4.25**	0.85
Conventional production methods should be used during the introduction phase of a H_2 transition	5	13	4	2	0	**3.88**	0.85
H_2 offers a sustainable solution for Europe's transport problems	5	10	9	0	0	**3.83**	0.76
Widespread use of H_2-based transport will bring:							
… economic costs	2	14	5	3	0	**3.63**	0.82
… economic benefits	1	8	14	1	0	**3.38**	0.65
… environmental costs	0	2	7	14	1	**2.42**	0.72
… environmental benefits	3	13	8	0	0	**3.79**	0.66
… social costs	0	3	12	9	0	**2.75**	0.68
… social benefits	1	7	10	6	0	**3.13**	0.85

3.2 Using conventional production options during the introduction phase of a hydrogen transition

In general, most stakeholders argued for using conventional hydrogen production methods (i.e. hydrogen production as a by-product of the chemical industry and hydrogen production from natural gas) in the short-term. This was evident from both the questionnaires and the break-out groups. As Table 2 shows, only 2 respondents disagreed with the statement 'Conventional production methods should be used during the introduction phase of a H2 transition'. Break-out Groups 1, 2 and 4 argued that the most attractive economic solution in the short-term is to use conventional production methods, while demonstrating and improving hydrogen and related technologies. Group 1 felt this approach would be needed for at least 5-10 years, but pointed out that as fossil reserves dwindle and new technologies improve (as industry begins to develop and use renewables), this situation will change. Thus, in 2007, the cheapest source is natural gas, but by 2030 it could be wind. By this time, Group 4 felt, hydrogen technologies would be better, too. In Group 2, one stakeholder felt the limitation to use only renewables in the introduction phase would pose additional barriers to a hydrogen transition: using only renewable energy would make the introduction of hydrogen too slow. For Group 4, the environmental advantages to using renewables would be greater for non-transport uses in the short term: they felt it would be more efficient to use renewables elsewhere than to power transport.

The groups discussed the advantages and disadvantages of different 'conventional' energy sources for hydrogen. Group 2 felt hydrogen from natural gas is a necessary stepping-stone to create the market for hydrogen technologies. Group 1 also discussed the role of natural gas in hydrogen production, but concluded the relationship between the two technologies could be problematic. While they felt the main conventional alternatives to petrol/diesel today are biofuels and compressed natural gas (CNG), they pointed out that a considerable number of EU member states have incentives for CNG and its share is expected to increase in the medium term; this will make hydrogen from natural gas more expensive in the medium term, because there will be increased competition for the natural gas resources. On the other hand, they pointed out, CHG cars emit methane (another GHG) and will also need a fuelling infrastructure, making it a less attractive option in the longer term. Group 1 queried whether nuclear counts as 'conventional', but in any case felt Europe will need to use fossil fuels with CCS. Furthermore, they pointed out that hydrogen is also a by-product of the chemical industry.

However, concerns were also expressed about using conventional energy sources in the short-term: there could be an image problem if 'dirty' technologies are used in the beginning, and therefore difficulties marketing hydrogen; furthermore, they felt it could be difficult to get away from conventional production methods if they become dominant (and locked-in) in the short-term. Group 3 were also concerned about the use of certain 'conventional' and non-renewable-based technologies in the short term, in particular nuclear and CCS (see below, and previous workshop results). Groups 2 and 4 also raised concerns about use of conventional energy sources. Group 2 stressed that, politically speaking, introducing hydrogen depends on having renewables as feedstocks (due to links with climate change abatement and the potential to retain economic benefits within Europe); thus, they agreed that the final aim must be hydrogen production from renewable sources. Group 4 also felt it important to highlight the ultimate end-point of the transition (and the temporary reliance on conventional feedstocks; thus a 'light at the end of the tunnel'); they argued for targets by when renewables should be widely used. Thus there would be a limit to any 'transition phase' – defined as when a particular level of hydrogen penetration was reached – after which renewable sources would have to be dominant.

Group 4 raised the issue of conventional vehicle technologies. This group felt that bringing hydrogen technologies to the market may require conventional propulsion systems as well as feedstocks: a dual-fuel hydrogen/petrol ICE may have a place when hydrogen infrastructure is scarce. They pointed out that demand for novel vehicle technologies requires the build-up of initial fuel infrastructure, and drew the comparison with flexi-fuel options for bioethanol.

3.3 Sustainability impacts of hydrogen and implications of the hydrogen model results

The questionnaire responses (see Table 2 and Appendix 3) show stakeholders were positive about the potential for hydrogen technologies to offer a sustainable solution to Europe's transport problems. When asked about the relative environmental, economic and social benefits of hydrogen, the largest proportion of respondents agreed that hydrogen offers *environmental* benefits (in fact, none disagreed with this statement); the next highest agreement was in relation to *economic* benefits (only one disagreed here); with the highest proportion (10) neither agreeing nor disagreeing about there being any *social* benefits.

In respect of costs of hydrogen-based transport, most participants felt that there would be *economic* costs (only 3 disagreed), while most (15) disagreed that there would be *environmental* costs. Again, the largest proportion (12) neither agreed nor disagreed about *social* costs.

The questionnaire responses suggest, then, that participants are ambivalent about the social and economic impacts of hydrogen-based transport, but are optimistic about its impact on environment.

The break-out groups highlight a range of social, economic and environmental concerns amongst stakeholders about hydrogen-based transport. Several felt that the modelling results may imply a move towards more unsustainable transport in some respects, depending on the assumptions under-pinning the models.

- *Social inequality:* Groups 2 and 4 both pointed out that expensive hydrogen technology will increase social inequality; those who cannot afford hydrogen vehicles will be excluded from this transition. This will become a more pressing problem as oil prices rise: in 2050, part of the population will not be able to pay for oil or hydrogen. More broadly, both groups questioned who will benefit from the widespread introduction of hydrogen technologies and (Group 4) concluded it would likely be the wealthy.
- *Carbon emissions from hydrogen production:* Group 1 cautioned against seeing hydrogen as an environmentally-sustainable technology, since this is dependent on how it is produced.

Indeed, Group 1 suggested that a hydrogen economy would be little different to conventional fossil-based one, which is why it is being pushed; yet, for public acceptance, the benefits have to be obvious today. This group felt that people generally do not understand that a 'hydrogen car' might have no CO2 emissions at point of use but that there might well be CO2 emissions from the production of hydrogen and from the production process. Thus vehicle emission labelling has to be correct, and should be based on well-to-wheel emissions. In the long-term, they argued, even hydrogen cars must be required to meet sustainability criteria, such as environmental considerations, renewable/secure supply, and cost-effectiveness.

- *Concerns about CCS and nuclear:* Related to the above, concerns were expressed in Group 3 about the use of nuclear and CCS in hydrogen production (both of which are assumed in the hydrogen scenarios). In respect of CCS, one stakeholder argued that it may not be socially acceptable or technically feasible ('the capture works, but storage not always; it's not feasible factually at some locations'); while others pointed to the disadvantages of nuclear in terms of storage, toxicity, lack of investments in nuclear due to risks, and unsolved problem of decommissioned power plants. One summed up the inherent problems with nuclear power as 'there are no free lunches'.
- *Unsustainability of economic, energy and transport growth:* More fundamentally, several stakeholders queried the assumption of unlimited growth (economic, energy use, mobility) which is implicit in models of a hydrogen transition. Group 3 felt the hydrogen pathways presented were unsustainable from the point of view of projected mobility and energy demand levels. One participant referred to 'flat earth economists' ignoring the impending demise of fossil fuel supplies after 2030; another argued 'we won't have fuels to run hybrids'. Indeed, most stakeholders felt the approaches did not lead to sustainable transport (which demands reduced energy use and modal shift). Group 1 expressed concerns about the inability of hydrogen technologies to tackle issues of congestion and land use, which already result from current road-based transport and mobility levels. Similarly, Group 2 pointed out that technology itself will not solve the unsustainability problems of mobility (congestion, inequality, etc.) Group 3 similarly expressed concerns about the profound issue of energy availability and mobility levels – both of which are finite – which are currently not considered in any modelling work. The current trends of car ownership are used to extrapolate future levels of ownership, but this is not feasible. Taking a global view, this is even more concerning given aspirations in China and India for car ownership and growth of the automotive industry in these regions. One participant was also concerned that the modelling scenarios link transport demand to economic growth: 'if we think economic growth is necessary to achieve social requirements, it's a self-fulfilling prophecy'.

3.4 Alternative approaches or visions to a hydrogen-based transport future

Alternative approaches (to hydrogen or biofuels) were also discussed, and these included both technological and behavioural options for a more sustainable transport system.

- Firstly, *different technologies* were raised by several stakeholders. Group 2 felt the main alternative technology is hybrid-electric cars, although it was pointed out that hybrid technology would inevitably replace conventional internal combustion engine (ICE) vehicles so the future choice would be between hydrogen and hybrid cars (not hydrogen and ICE). Group 2 felt completely electric cars would not be a viable alternative without a breakthrough in battery technologies, a view shared by at least one participant in Group 3. Although it was raised as a possibility, inadequate range due to currently limited battery capacity per unit of weight and long recharging periods was felt to be a serious constraint.
- Secondly, *modal shift* was felt to be important for most groups. Modal shift was a central concern for Group 4. They felt socially-sustainable transport requires greater use of public transport, which (unlike hydrogen technologies) can tackle increasing social inequalities.

They felt inequality cannot be solved with progressive taxes, which are already high in Europe; since people need mobility, revenues from transport/emissions taxes should be used to promote modal shift. In this sense, governments should help ensure sustainable forms of mobility are provided. More fundamentally, society as a whole (not only those on lower incomes) should explore how to use resources more efficiently than they currently do. Thus, it is not realistic to assume that every person in the world will own a car; car *use* should be more important than ownership. Several members of Group 3 also argued for modal shift; one stated 'It's not a question of shifting to H2, but of changing business models and practices' to provision of mobility services (not products); a 'new view of cars'. On the other hand, another participant pointed out that public transport is generally not CO2-free so should not be considered as a panacea for unsustainable transport. Furthermore, there was disagreement about the relative advantages of public versus private transport: one member of Group 3 argued that public transport means compromise and constraints of freedom (due to timetabling, having to share with smokers, not being able to play music, etc.), whereas another described the pleasures of using public transport (more relaxing, faster if high-speed trains, in-car dining, etc.).

- Thirdly, some members of Group 3 felt sustainable transport demands *reduced mobility* levels. This view was evidently not shared by everyone; in general, modal shift and energy efficiency were felt to be sufficient to produce a more sustainable transport system. Members of Group 3 debated whether to maintain or reduce mobility levels, and the role of personal transport. One participant felt reducing mobility means sacrificing social relationships (i.e. visiting friends in other countries), whereas another argued for 'weaning people off' the need to travel by choosing to live closer to friends/ family and implementing context-specific approaches to mobility management.

3.5 Usefulness of the hydrogen modelling results for policy assessment

Group 2 felt the usefulness of models depends to some extent on the data and assumptions used, and that this should be made more explicit. It was pointed out that there have been dramatic changes of assumptions in recent years, particularly relating to crude oil price and GDP growth. For example, in 2003 it was said that biodiesel would be competitive at an oil price of 40 US$. Furthermore, some of the models were criticised for being solely trend-forecasts (and do not consider alternative pathways). On the other hand, one participant in this group argued that feedbacks in more complex (non-linear) models can change your initial assumptions.

In relation to this issue, Group 1 felt it is important to note the Joint Technology Initiative decision on hydrogen and fuel cells. This will require continuing input from model results, e.g., on employment, GDP effects, etc.

Concerns about the possible unsustainability of hydrogen (see above) suggest these issues would be usefully addressed in policy assessments of hydrogen. Furthermore, Group 2 felt knowledge is still lacking about the social sustainability of these technologies.

4 Stakeholders' views about the relative roles of hydrogen and biofuels in sustainable transport

Both the questionnaire responses and break-out group discussions show most stakeholders feel biofuels and hydrogen are compatible rather than competing transport technologies. As shown in Table 3 (see also Appendix 3), only 5 participants disagreed that 'There is a role for both biofuels and H2 technologies within Europe's transport system', and only 3 agreed that 'Transport technology strategies in Europe should focus on either biofuels or H2, not both; similarly, only 4 agreed that 'There is strong competition between biofuels strategies and H2 strategies within European transport'.

Group 2 felt biofuels and hydrogen are compatible technological strategies. Indeed, members of this group felt all solutions will be needed to make transport more sustainable, but felt in the longer term hydrogen offers more advantages than biofuels. They felt the question of biomass potential has to be dealt with; while hydrogen offers a solution for storage problems of renewables (e.g., wind power) and it might be easier to transport than electricity.

Group 1 felt these two technologies may not compete currently, but could do in the longer term: they highlighted the significance of biofuel targets that already exist in the EU, while hydrogen still needs technological breakthroughs on fuel cells. If there is success here, they felt hydrogen would take over. There is interest in achieving the latter because it would not require radical system changes. The interest in fuel cells is also fired by the knowledge that there is a big market, if the technology is improved. In the long term, Group 1 felt biofuels are not competitive, except perhaps in selected markets, such as marine applications.

Furthermore, they argued that biofuels cannot replace all oil-based transportation. They argued there are two options for cars in the long term – electricity or hydrogen with fuel cells. On the other hand, hydrogen is not suitable for marine or air transportation. Yet, Group 1 concluded that none of these transport solutions is fully sustainable, since they do not stimulate modal shift.

Views about the sustainability of biofuel technologies in transport were divided. As shown in Table 3, 10 participants agreed with the questionnaire statement ‘Biofuels offer a sustainable solution for Europe’s transport problems’, and the same number disagreed. While a little over half the respondents (14) agreed that widespread biofuel-based transport would bring *environmental benefits*, a significant minority (9) agreed that it would bring *environmental costs*. Similarly, the same number (9) agreed that biofuel transport would bring *economic costs* as agreed it would bring *economic benefits*, while the largest proportion in each case neither agreed nor disagreed. Finally, most were undecided about the *social costs and benefits* of biofuels; in each case only 4 respondents agreed, while most neither agreed nor disagreed. *Overall, it seems stakeholders are ambivalent about biofuels as a sustainable strategy for transport.*

In the break-out groups, some participants also expressed reservations about biofuels, while others were more positive about their potential. For example, Group 2 felt the question of biomass potential has to be dealt with, while Group 1 raised practical barriers to widespread biofuel use (see above). On the other hand, Group 4 discussed the benefits of biofuels: they are promoted for security of energy supply and competition reasons as much as for environmental sustainability.

Table 3. Stakeholders’ attitudes to hydrogen versus biofuel technologies

Attitude Statement	**Agree strongly (5)**	**Agree (4)**	**Neither agree nor disagree (3)**	**Disagree (2)**	**Disagree strongly (1)**	**Mean**	**SD**
There is a role for both biofuels and H_2 technologies within Europe’s transport system	9	10	0	4	1	**3.92**	1.21
Transport technology strategies in Europe should focus on either biofuels or H_2, not both	2	1	0	11	10	**1.92**	1.18
There is strong competition between biofuels strategies and H_2 strategies within European transport	0	4	4	15	1	**2.46**	0.83
Biofuels offer a sustainable solution for Europe’s transport problems	0	10	4	9	1	**2.96**	1.00
Widespread use of biofuel-based transport will bring:							
… economic costs	0	9	10	5	0	**3.17**	0.78
… economic benefits	0	9	13	2	0	**3.29**	0.62

Table 3 cont.

Attitude Statement	Agree strongly (5)	Agree (4)	Neither agree nor disagree (3)	Disagree (2)	Disagree strongly (1)	Mean	SD
… environmental costs	1	8	8	7	0	**3.13**	0.92
… environmental benefits	1	13	7	2	1	**3.46**	0.88
… social costs	0	4	14	6	0	**2.91**	0.67
… social benefits	0	4	11	9	0	**2.79**	0.72

The questionnaires also elicited stakeholders' views about the relative role of transport technologies *in general* to foster sustainable mobility (see Table 4). Almost two-thirds of respondents agreed that 'introducing new transport technologies is the main way to foster a sustainable transport system in Europe', whereas less than one-third disagreed. *This is consistent with the technocentric views expressed by many in the break-out groups*.

Table 4. Stakeholders' attitudes to sustainable mobility

Attitude Statement	Agree strongly (5)	Agree (4)	Neither agree nor disagree (3)	Disagree (2)	Disagree strongly (1)	Mean	SD
Introducing new transport technologies is the main way to foster a sustainable transport system in Europe	6	9	2	6	1	**3.52**	1.27

5 Stakeholders' views about sustainable hydrogen, biofuel and mobility policies

In considering how to achieve a more sustainable transport system, stakeholders in the break-out groups raised a number of barriers:

- *Institutional and infrastructural inertia:* Group 4 pointed out that current dominant transport systems and processes are defined by 50 years of development. Changing this would require a long-term vision, but there is much institutional and infrastructural inertia that impedes change. For example, even a tripled oil price has historically only produced very slow development.
- *Status and identity attached to cars:* Group 3 pointed to the emotional and cultural barriers to tackling car use. One member argued 'people personalise cars; the most emotional link you have to a product is to your car; it's a symbol, a flag you wave', having a 'car with a badge' is more important than the brand of other products. Public transport users in the group also recognised this as a widespread problem: 'I don't mind sharing but others do'. Indeed, research was cited which points to the reluctance of most people to give up their car in the face of economic disincentives: 'if gasoline prices increase people tend not to cut down on car use, but rather give up cigarettes or change other aspects of living, like housing'. This is another type of lock-in because 'people get used to this way of thinking'.
- *Consumer preferences and choices:* In Group 3, it was agreed that available infrastructure and alternatives influence attractiveness of transport options – 'rationality is linked to

circumstances'. For example, living in a city where parking is expensive or very difficult makes driving less attractive than using public transport; on the other hand, where cities do not have good public transport or car share schemes, driving may be the more feasible option ('In Heidelberg, the alternatives are not so good; I need my car').

- *Socio-economic trends:* There was disagreement about the extent to which urbanisation and economic growth are fostering modal shift or simply promoting 'car culture'. One participant in Group 3 argued that 'people are becoming more urban, and the rich live in the cities where there's usually good public transport'; while another argued 'the rich in China are buying cars' and that in some cities (e.g., Manhattan) the rich live outside the city but travel to work inside it.

In general, stakeholders favoured technological and economic (and to a lesser extent, institutional and educational) approaches to overcoming these challenges and fostering sustainable transport:

- *RD&D and economic incentives for novel technologies:* Group 2 felt a mix of measures is needed to introduce novel transport technologies like hydrogen and biofuels, including further R&D, demonstration projects, investment subsidies, tax exemptions, and so on. They stressed the need for political commitment and the political follow-through on promises: measures should be evaluated and adjusted continuously, but uncertainty among investors should be avoided and trust in political promises maintained.
- *Emissions-based taxation:* Although there was some support for EU-level subsidies to promote sustainable mobility, Group 4 favoured taxation on emissions over subsidies for particular technologies; the latter would avoid locking in inefficient/inferior technologies. (One participant felt this had happened in respect of solar panels in Germany, which have been subsidised but take years to be cost-effective). Furthermore, this group suggested subsidies can be difficult to remove. Here, they gave the example of coal, which was subsidised on social grounds, but subsidy removal is now proving difficult. Thus, Group 4 felt that if subsidies are to be used for hydrogen technologies, they should be clearly limited in time. Overall, the group favoured using emission-based policy instruments, and letting the market decide which technology succeeds: 'The power of technological development is underestimated, if only the rules of the game are clear'. Like Group 1 (see above), Group 4 favoured policies based on source-to-service analyses. The Californian approach of tax on carbon content, in combination with required conversion efficiency, was considered a good model. Group 2 also warned against unintended consequences of using subsidies to support new technologies.
- *Taxes for energy efficiency:* Group 4 felt genuine sustainable development requires reduced energy demand, which in turn leads to reduced company revenues and government taxes. That is, inefficient technologies currently lead to larger revenues. To change this perverse situation, this group felt we need taxes that promote efficient use of energy. One problem they acknowledged with taxes, though, is that the added cost is often shifted to consumers directly due to monopolistic status of some markets (e.g., in the case of the energy sector, the emissions trading scheme has only led to higher cost for consumers). This highlights the need to address social equity issues, as discussed earlier.
- *Support for hydrogen production technologies:* Group 4 mentioned support for production technologies for sustainable hydrogen. In particular, they felt CCS policies should be promoted. (This contrasts with the views of some members of Groups 2 and 3, who were unsure about the sustainability or viability of CCS).
- *Technologies for energy efficiency/ logistics:* In contrast to several others in Group 3, one participant favoured a more incremental technological approach; rather than tackling car ownership, he felt it was more appropriate to improve the way we use cars (e.g., by implementing global positioning systems [GPS]). Energy efficiency was also strongly supported by participants in Group 4.

- *Public investment in infrastructure:* Group 4 cited the importance of investing in high-speed rail infrastructure (see below), but felt cycle lanes are an example of more cost-effective infrastructure to promote modal shift (as evident in many parts of the Netherlands and several German cities).
- *Mobility management:* As mentioned earlier, some (though certainly not all) stakeholders favoured demand management measures. Group 1 felt the most important need is to reduce demand for mobility and that this will be achieved through prices first and foremost. They argued for economic measures such as not allowing tax reductions for commuters, subsidising public transportation, etc. They also felt demand from the freight sector must be tackled. In general, Group 3 felt there is a need for policy interventions to promote sustainable mobility: one argued ‘more rational ways to commute need a strong outside influence’; and another ‘we will need draconian measures to curb the number of cars’.
- *Education:* Group 4 suggested education to teach other values to the young and to change consumption patterns is necessary to overcome many lock-ins to unsustainable transport; and here they argued that media have a responsibility.
- *Localised decision-making structures:* Group 4 felt a shift to sustainable transport demands a more local approach to decision making, which supports markets and freedom, but with local policy jurisdictions in order to change behaviour slowly but steadily. They indicated that politics and dominant attitudes can make modal shift difficult to achieve, and suggested people behave differently only if they see alternatives working. Here, they cited the example of high-speed trains [in Germany] which work well, but required a 40-year public investment. While this group cautioned against governments applying draconian measures to foster behaviour change, they recognised that growing social inequality must be addressed.
- *Global perspective:* Conversely, Group 1 argued for the importance for a global perspective on sustainable mobility. They pointed out that prices will increase rapidly due to economic growth in developing countries. Thus, Europe will be affected by developments in the rest of the world; and solutions have to be found that are sustainable for the planet as a whole. This was a concern also raised in Group 3, in respect of rapid growth in car ownership in India and China. However, there was disagreement about where, or whether, mobility demand should be curbed; one participant felt ‘we don’t have too many cars in the EU’; whereas another pointed out it is unfair to limit mobility in developing countries if the developed world is unprepared to do the same. Again, this highlights the issue of equity.

The questionnaire responses indicate similar policy preferences amongst stakeholders to those raised in the break-out groups. When asked about policies to foster sustainable hydrogen transport (see Table 5), the highest proportion of respondents suggested RD&D, while economic measures - particularly subsidies for hydrogen - were also widely supported. Regulation was a less popular response, suggesting *stakeholders preferred a market approach to a possible hydrogen transition*. These responses are largely consistent with the views expressed by stakeholders at the first workshop; here, promotion of renewables, economic measures, technological development, and public education were policy measures most commonly supported.

Table 5. What policies are most appropriate to foster a sustainable hydrogen-based transport system in Europe? (open—ended question)

RD&D:	
Research / RD&D	12
Support CCS for H_2 from coal	1

Table 5. cont.

Economic policies:	
Tax reduction / subsidisation on fuel / H_2	9
Build up of filling stations, subsidies for infrastructure	6
Carbon taxation / tax on conventional fuels	5
FC subsidies, support	3
Investment subsidies	3
Price / internalising externalities / subsidies in market entry phase	3
Long-term framework to ensure security of investments	1
Congestion charging	1
Regulation/standards:	
Reduction of fuel demand / carbon quotas	2
Renewables/emissions policies	2
Regulation / law	1
Behaviour/value change:	
Education on sustainability and environment	1
Foster transport services (public, car sharing)	1
No answer	1

Table 6. What policies are most appropriate to foster a sustainable biofuel-based transport system in Europe? (open—ended question)

Economic policies:	
Carbon tax / tax policies / tax exemptions	10
Investment subsidies	3
Subsidies for biofuels	3
Price/ economic instruments	2
Tax reductions in the beginning only	1
Open market for agricultural goods, stop food subsidies, let biofuel markets develop	1
Abolish bioethanol import duty	1
Long-term framework to ensure security of investments	1
RD&D:	
RD&D	3
Regulation/standards:	
Regulation for biofuel/fossil mix	1
Set biofuel standards	1
Renewables/emissions policies	1
Quota systems	1

Table 6 cont.

Behaviour/value change:	
Education on sustainability and environment	1
None / Do not foster!	4
No answer	2

When asked what policies are appropriate to foster biofuel-based transport (see Table 6), respondents again favoured *economic measures*, particularly carbon taxes with exemptions for biofuels. It is noteworthy that 4 respondents argued that no policies should be applied, because biofuels should not be supported. This reflects the more ambivalent views towards biofuels in the other questionnaire responses (Table 3) and break-out group discussions.

In respect of policies to foster sustainable mobility (see Table 7), *economic policies* are again popular, but provision of public transport services is also seen as important. *Consistent with the break-out group discussions, we see here a preference for novel vehicle/fuel technologies (e.g., via R&D polices and subsidies) and modal shift, whereas reduced mobility demand (e.g., via land-use policies) is less popular.*

Table 7. What policies are most appropriate to foster sustainable mobility in Europe? (open—ended question)

Economic policies:	
Pricing policies	6
Taxation	4
Shipping and operation taxes/tolls	1
Regulation/targets:	
Reduced parking in cities	1
Regulation	1
Carbon intensity target on fuel supply	1
RD&D, technology:	
R&D of new technologies	4
Subsidies for alternative fuels and infrastructure	2
Increase vehicle/fuel efficiency	1
Demonstration projects	1
H_2 is long-term solution; biofuels only mid-term	1
Behaviour/value change:	
Support/provision of public transport	6
Modal shift / car sharing	3
Local lifestyles/reduced demand/land-use planning	2
Reduction of energy consumption	2
Changing/influencing behaviour	1
Changing attitudes (question need for SUVs)	1
Abolish paradigm of endless economic growth	1

Table 7 cont.

Individual transport by car / individual transport	2
No answer	2

Group 4 participants were asked about how useful they felt the MATISSE WP9 transition model of sustainable mobility might be for policy assessment. They agreed it is important to apply a broad definition of sustainability, but felt this should go further to include all of society. They found it difficult to say something concrete about this as it is such a broad issue. However, they did suggest such analysis should consider the importance of new technologies using old infrastructure (e.g., roads used initially for horse-drawn cars could later be used by cars).

6 Analysis of the process

The questionnaires provided an opportunity to explore whether the break-out groups had fostered social learning. In total, almost a third of stakeholders (7 out of 24) felt they had changed their views about the topics discussed in the groups (Table 8). When asked what they had learned from the discussions, most stakeholders (15) felt they had learnt something (Table 9). Interestingly, 2 of these (one in Group 4, a heterogeneous group; and one in Group 2, a homogeneous group) noted the divergence of opinions, while 2 (both in Group 4) felt there was consensus amongst discussants.

Table 8. Do you feel the break-out discussion has changed your views about any of the topics discussed?

	Total	Homogeneous groups	Heterogeneous groups
Yes	**7**	4	3
No	**10**	5	5
Don't Know	**5**	3	2
No answer	**2**	2	0

Table 9. What, if anything, do you feel you have learned from the break-out discussion?

Divergent opinions (despite sharing same analysis)	2
Consensus between discussants	2
Complexity and contingency	2
Information about hydrogen	1
Problems of introducing hydrogen cars	1
Multiple solutions needed for H2 and biofuels introduction	1
Discussion too focussed on supply, not individuals' acceptance	1
Different technologies are necessary	1
Global view is necessary	1
Renewable energies will become competitive due to rising oil prices	1
transport modes and modal split for different distances	1
wind energy considered for H2 production	1

Table 9 cont.

Various	1
learning during whole workshop	1
experts are relatively clueless	1
No answer	9

As noted in the report of the last workshop (Whitmarsh et al., 2006), it was evident from the break-out group discussions that stakeholders sometimes answered questions from the point of view of their personal experiences (e.g., membership of a car share scheme in Karlsruhe) and preferences (e.g., enjoying taking the train) and sometimes from their professional knowledge of transport (e.g., consumer preferences, technical possibilities, resource constraints). This reminds us that all stakeholders are transport users, while some also have technical expertise relevant to sustainable transport. As argued elsewhere (Whitmarsh et al., 2007), we should therefore avoid suggesting there is a clear distinction between experts and lay/citizens in respect of transport issues.

7 Summary and conclusions

The stakeholder workshop discussed here has formed part of an iterative process of consultation and social learning with stakeholder groups in conducting Integrated Sustainability Assessments (ISAs) of sustainable hydrogen and mobility within the MATISSE project. The findings from this latest stakeholder workshop offer valuable feedback on the hydrogen and mobility transition modelling work conducted to date within MATISSE, and highlight areas where further work may be needed to modify the visions and assumptions underpinning the models, and to examine the impacts of particular policies and social changes on the sustainability of Europe's transport systems.

In respect of the vision of sustainable hydrogen-based transport developed in MATISSE, stakeholders agreed with the assumption that different countries should use different feedstocks and production technologies, and discussed the various advantages of this approach. Furthermore, most stakeholders agreed that it will be necessary to use conventional hydrogen production methods in the initial phase of a hydrogen transition, before moving towards a renewable-based transport system. However, they pointed to certain risks with this approach, such as hydrogen being associated with polluting feedstocks (and thus receiving no political or public support) and becoming locked into fossil-based production methods. Thus, they emphasised the need for a clearly defined transition period and targets for renewables to be phased in. As in the previous workshop, some stakeholders expressed concerns about the use of CCS and nuclear in hydrogen production.

The sustainability implications of the modelling results were discussed by stakeholders. Overall, the questionnaire results show stakeholders are ambivalent about the social and economic impacts of hydrogen-based transport, but are optimistic about its impact on environment. Furthermore, the break-out group discussions revealed concerns that a hydrogen transition may imply a move towards more unsustainable transport in some respects, depending on the assumptions under-pinning the models. Particular concerns included: social inequality (due to high costs of hydrogen technologies); carbon emissions from hydrogen production (and a lack of public awareness of this); concerns about the feasibility and sustainability of CCS and nuclear for hydrogen production; and – more fundamentally – unsustainability of the projected economic, energy and transport growth assumed in the models.

These concerns about the possible unsustainability of hydrogen suggest these issues would be usefully addressed in policy assessments of hydrogen. Indeed, most participants advocated an alternative sustainable transport vision – most commonly, a 'modal shift' vision – to be considered in addition to a hydrogen-based transport vision.

Alternative transport technologies (biofuels, hybrid-electrics) and reduced mobility demand were also discussed, though there was less agreement about the merits of these alternatives. Biofuels, for example, were seen as a possible complementary transport technology (to hydrogen) but stakeholders were ambivalent about the relative costs and benefits of these biofuel technologies.

Overall, it was interesting that stakeholders at this workshop were very optimistic about the role of transport technologies in tackling problems of unsustainability. This is despite their evident awareness of the socio-cultural and institutional aspects of the problems. Indeed, consistent with the previous workshop, stakeholders at this workshop did not equate sustainable hydrogen with sustainable transport, and argued for modal shift. Nevertheless, the technocentric perspective of many of these stakeholders contrasts with the emphasis in the citizens' workshops on behavioural and institutional change measures (Whitmarsh et al., 2007).

A further aim of the workshop was to elicit stakeholders' views about the usefulness of the modelling tools and findings for policy assessment. Stakeholders felt the value of such tools depends to an extent on the data and assumptions underpinning them, many of which have been discussed in this report. In general, they were positive about the potential to model a sustainable mobility transition, despite warning that the breadth of the issue could make concrete analysis difficult.

In respect of particular policies that should be assessed, stakeholders particularly favoured economic measures, such as carbon/emissions taxes, and RD&D to promote novel technologies. However, stakeholders warned that such policies should avoid locking in inefficient technologies or exacerbating social inequalities. In general, regulation was less popular than market-based approaches to introducing novel technologies like hydrogen. Investment in public transport infrastructure, public education, and institutional changes (e.g., to avoid global inequalities, to develop locally relevant solutions) were also suggested for promoting sustainable transport.

A final aim of the workshop was to foster social learning, through group discussion, amongst both stakeholders and researchers. As in the last workshop, around a third of stakeholders said they had changed their views as a result of participation in the break-out groups; and most said they had learnt something. In turn, MATISSE researchers will now use the feedback and views of stakeholders in the ISA planning processes and tool development in WP7.1 and WP9. In particular, the sustainability visions may be adapted or extended, and the policy assessment questions selected, based on the findings from this workshop. Further work will also consider (and compare) the views of these (largely academic) stakeholders and those from more diverse backgrounds in order to ensure a range of views and expertise are represented in the ISA processes.

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Appendix 1 - Break-out group questions for stakeholder workshop discussions

www.matisse-project.net

Break-out group questions for stakeholder workshop discussions

Introduction

The break-out group discussion is intended to elicit stakeholders' views on sustainable transport technologies, with particular focus on hydrogen and biofuels. Although others have suggested what sustainable hydrogen and biofuels mean, we are interested in your views as stakeholders with unique expertise, experience and perspectives.

As at the previous workshop, the information gathered via these break-out groups will be used within the MATISSE project to develop sustainability criteria, design relevant policy assessments, and refine scenarios as part of an Integrated Sustainability Assessment (ISA) of transport.

All information gathered is **completely confidential** and hence no names will be disclosed in future reports and publications. Preliminary results from the break-out sessions will be presented at the end of the afternoon, with a further opportunity for comment and discussion. Final results from the sessions will be circulated to all workshop participants following the workshop. *Your participation is very valuable for our research; thank you for your contribution.*

Discussion

1) Feedback on hydrogen visions and modelling results

There is a range of visions about hydrogen feedstock and production including those from the MATISSE project. What are your views on the following questions?

- Does it make sense to use different technologies in different areas/European countries (e.g., nuclear, renewables, fossil with carbon capture and sequestration)?
- What are the advantages and disadvantages of using conventional production options during the introduction phase of a hydrogen transition? Would such a strategy lead to criticism of the notion of a hydrogen transition?
- Are the proposed approaches sustainable (environmentally, socially and economically)?
- Are there alternative approaches or visions that should be considered?

What are the sustainability implications of the hydrogen modelling results?

- For example, what are the environmental, social and economic considerations?

What are your views about the usefulness of the modelling results for policy assessment?

2) Hydrogen and biofuels for transport

Is there a strong competition between biofuels and hydrogen strategies, or are these approaches compatible? Can you please explain in what way(s)?

Which is the more sustainable strategy for road transport?

- What are the economic prospects for growth of each technology? What are the environmental and social implications?

What policies are most appropriate to foster a more sustainable hydrogen- or biofuel-based transport system in Europe?

3) Sustainable mobility

What policies, or social and economic changes, are needed to foster a sustainable mobility system in Europe?

Do you think it is useful, or feasible, to model transitions to sustainable mobility? If so, how?

- Do you have any comments on the mobility transition model presented earlier?

Appendix 2 - Stakeholder self-completion questionnaire

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MATISSE Stakeholder Questionnaire - sustainability, hydrogen & biofuel transport

Introduction

This short questionnaire is intended to elicit stakeholders' views on sustainable transport technologies, with particular focus on hydrogen and biofuels. The information gathered via this questionnaire and the break-out discussion groups will be used within the MATISSE project to develop sustainability criteria and to design relevant policy assessments as part of an Integrated Sustainability Assessment (ISA) of transport. ISA is a stakeholder-centred process, which values stakeholders' unique expertise and concerns. Therefore, your views are crucial.

All information gathered is **completely confidential**. Key findings from this survey will be circulated to all workshop participants following the workshop.

Section A Your role and interests in transport and transport technologies

1. Which of the following best describes the organisation you work for:

Academia/ Research Organisation ☐

Automotive Industry/ OEM ☐

Transport Industry (other) ☐

Energy Industry ☐

Government ☐

Non-Governmental Organisation ☐

Other: ______________________________

2. What are your/ your organisation's goals vis a vis transport?

3. How important are considerations of ‘sustainability’ to your organisation’s goals and decision-making for transport?

Very important ☐

Quite important ☐

Not very important ☐

Not at all important ☐

Section B Your views about sustainable transport technologies and mobility

4. Please indicate how much you agree or disagree with the following statements by **ticking one box on each row**:

	Agree strongly	Agree	Neither agree nor disagree	Disagree	Disagree strongly
a. The choice of hydrogen feedstocks and production technologies (e.g., nuclear, renewables, carbon capture & storage) should be different within each European country	☐	☐	☐	☐	☐
b. Conventional production methods should be used during the introduction phase of a hydrogen transition	☐	☐	☐	☐	☐
c. Hydrogen offers a sustainable solution for Europe’s transport problems	☐	☐	☐	☐	☐
d. There is strong competition between biofuels strategies and hydrogen strategies within European transport	☐	☐	☐	☐	☐
e. Transport technology strategies in Europe should focus on either biofuels or hydrogen, not both	☐	☐	☐	☐	☐
f. Biofuels offer a sustainable solution for Europe’s transport problems	☐	☐	☐	☐	☐
g. There is a role for both biofuels and hydrogen technologies within Europe’s transport system	☐	☐	☐	☐	☐
h. Widespread use of hydrogen-based transport will bring environmental benefits	☐	☐	☐	☐	☐
i. Widespread use of hydrogen-based transport will bring economic benefits	☐	☐	☐	☐	☐
j. Widespread use of hydrogen-based transport will bring social benefits	☐	☐	☐	☐	☐
k. Widespread use of hydrogen-based transport will bring environmental costs	☐	☐	☐	☐	☐
l. Widespread use of hydrogen-based transport will bring economic costs	☐	☐	☐	☐	☐
m. Widespread use of hydrogen-based transport will bring social cost	☐	☐	☐	☐	☐
n. Widespread use of biofuel-based transport will bring environmental benefits	☐	☐	☐	☐	☐
o. Widespread use of biofuel-based transport will bring economic benefits	☐	☐	☐	☐	☐

	Agree strongly	Agree	Neither agree nor disagree	Disagree	Disagree strongly
p. Widespread use of biofuel-based transport will bring social benefits	☐	☐	☐	☐	☐
q. Widespread use of biofuel-based transport will bring environmental costs	☐	☐	☐	☐	☐
r. Widespread use of biofuel-based transport will bring economic costs	☐	☐	☐	☐	☐
s. Widespread use of biofuel-based transport will bring social costs	☐	☐	☐	☐	☐
t. Introducing new transport technologies is the main way to foster a sustainable transport system in Europe	☐	☐	☐	☐	☐

5. What policies are most appropriate to foster a sustainable hydrogen-based transport system in Europe?

6. What policies are most appropriate to foster a sustainable biofuel-based transport system in Europe?

7. What policies are most appropriate to foster sustainable mobility in Europe?

Section C Your feedback on the break-out groups

8. Do you feel the break-out discussion has changed your views about any of the topics discussed?

Yes ☐

No ☐

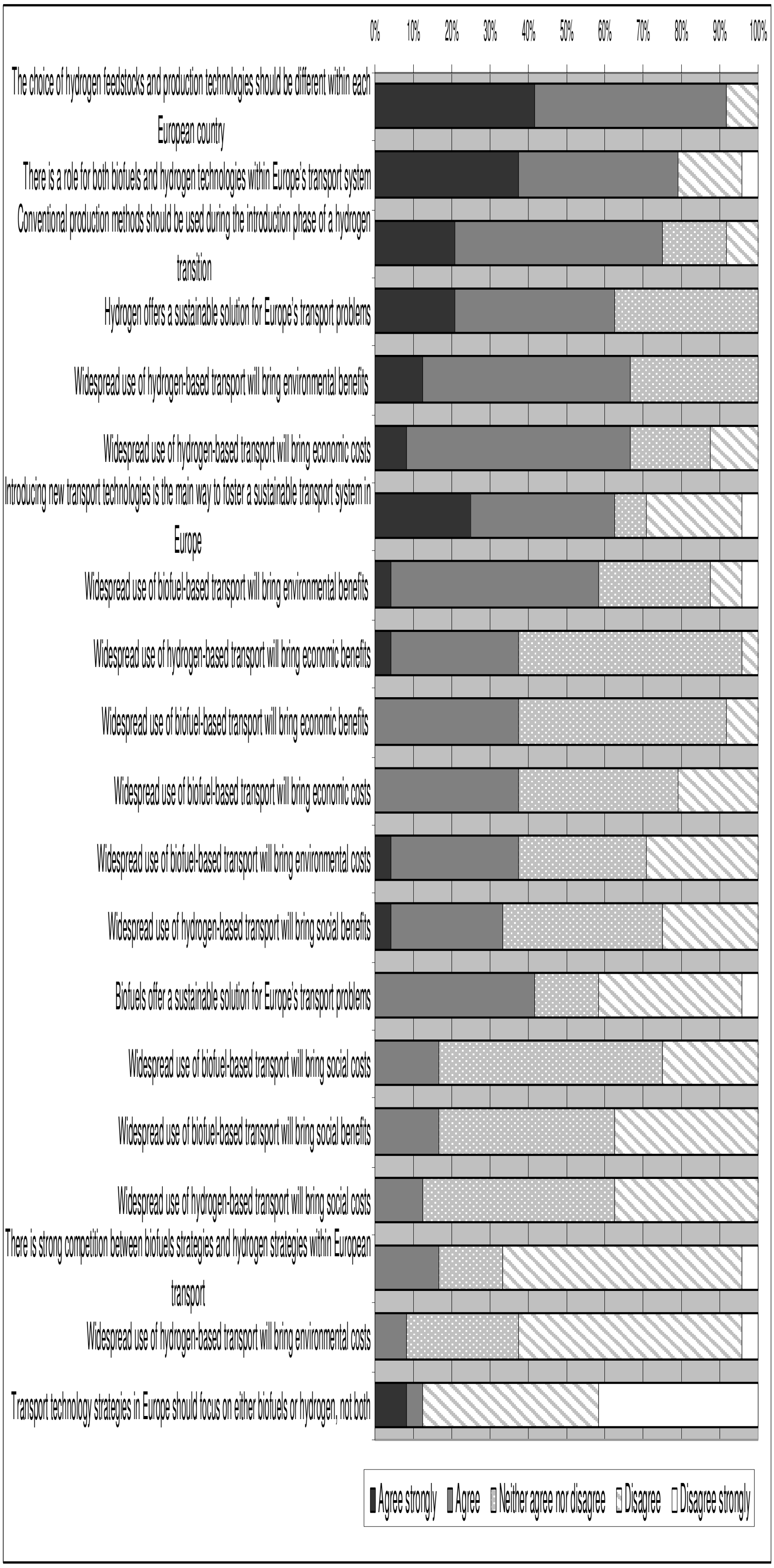
Don't know/ Not applicable ☐

9. What, if anything, do you feel you have learned from the break-out discussion?

Thank you very much for taking the time to complete this questionnaire.

If you have any further comments, please write them on the back of this sheet.

Appendix 3 - Stakeholders' attitudes to hydrogen, biofuels and sustainable transport (Questionnaire findings)



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