Organisation of Surveys on Attitudes Towards Hydrogen as Energy Carrier

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Abstract

Use of renewable energy resources, including hydrogen energy is on agenda for energy developers. Popularity of renewable energy is growing constantly. There are lots of successful projects and more often companies and different societies start to implement renewable energy projects to manage efficient financial resource spending as well as reduce the impact of energy suppliers. Lots of good practice examples are examined and developed world wide, including operation of university campus, public transport, operation of villages, etc. Paper examines surveys and their organisation for the readiness of acceptance of renewable energy resources and in this case – hydrogen for energy supply of Academic Centre of University of Latvia. In the survey were questions on respondent's, attitudes, behaviour, some environmental knowledge as well as information on socio-economic characteristics of respondents, including, questions about the hydrogen energy acceptance, scientific value and safety issues. The main conclusions are that developed survey organisation can be used also for research in other groups of segments and the main survey results shows acceptance for the hydrogen as energy source. Methods used for analysis: scientific publications research, evaluation of practical knowledge transfer and public opinion examination tools and marketing tools application evaluations using questionnaires. For data processing and analysis indicators of central tendency or location and variability, crosstabulations were used.
Keywords: surveys on attitudes, knowledge evaluation, public acceptance, hydrogen energy

1 Introduction and theoretical background

Already for several decades researchers worldwide work on hydrogen as energy carrier, on opinion research about those issues – the results are discussed in solid international scientific conferences and published in numerous scientific publications. Different countries have different approach and different attitude of public and politicians as well as implementation of the findings in everyday life: on acceptance of hydrogen technologies lot of research is done in Germany (Altmann, *et al.* 2012*)*, in Australia (Dicks, *et al.* 2004), in Wales (Cherryman, *et al.* 2005), in the Netherlands (Zachariah – Wolff, *et al. 2004),* in China (Cropper, 2002a), in India (Cropper, 2002b), in Norway (Bak, 2003), in USA (Bak, 2004) and (Schmoyer, *et al.* 2004), in Brazil (Hotza, *et al.* 2008), in London, Teeside ans Wales (Ricci, *et al. 2006),* in Lithuania (Milciuviene, *et al. 2006),* in some extent also in Latvia (Dimants, *et al,* 2012), in Iceland many discussions are realised and already implemented – hydrogen as future hydrogen economy (Aranson, *et al.* 2000), on

public acceptance (Dressner, *et al.* 2007) and (Wilsdon, *et al. 2004),* on hydrogen production (Turner, *et al.* 2008 and by UNEP, 2006), as energy carrier ((Wietschel, *et al.* 2007) and (Zhang, 2010)), on hydrogen technologies (Hagen, 2003) and (Waegel, *et al. 2006),* on hydrogen production from waste (Rabah, *et al.* 1989), on issues in the public perceptions of risk (Flynn, 2004). Different sources for hydrogen production are evaluated by political, economical and environmental aspects (Balat, *et al.* 2009), (Meisen, 1996), (Ricci, *et al.* 2008 and 2007 and 2006), (Wilk, *et al.* 2007), on fuel cells (Cropper, *et al.* 2004), on transition to renewable energy systems with hydrogen as an energy carrier (Barbir, 2009), forecasts, scenarious as well as visions are evaluated by McDowal and Eames (McDowall, *et al.* 2006, 2007). Hydrogen futures toward a sustainable energy system is covered in several research works (Dunn, 2001), as well in European Commission, for transport (Farell, *et al.* 2003), and (Bellaby, *et al.* 2007), (Li, *et al.* 2010) for public buses in Stokholm (Haraldsson, *et al.* 2006), several aspects on hydrogen vehicles (O'Garra, 2012, 2007 and 2005), on hydrogen fueling stations (Fuel Cells, 2000). A global survey of hydrogen energy research, development and policy are in depth researched already many years ago (Solomon, *et al.* 2006).

The term "*hydrogen economy*" was formulated in 1970 by the 20th century remarkable electrochemist John O'Mara Bockris (Bockris, 2002) as an alternative to oil and coal-based economy of today. The non-renewable energy resources of oil, natural gas, coal on the Earth are limited and not restored quickly enough to compensate the growing consumption year from year. But hydrogen, although does not occur in the free form on Earth, can be obtained using renewable energy (wind, sun, water, geothermal) and renewable resources (biomass, water). Hydrogen as a fuel can be used for transport, and production of heat and electricity; the hydrogen combustion (both directly in internal combustion engines, boilers and chemically in fuel cells) does not pollute the environment with carbon and its compounds (soot, hydrocarbons, carbon monoxide CO, carbon dioxide CO_2. In addition, if fossil energy resources on Earth are not everywhere, and the battle for ownership of the deposits is related to the cruel wars of all time, even today, when renewable energy and renewable resources are to be acquired in almost every country in the world. Therefore, a wide transition to hydrogen as an energy carrier and fuel, or *Hydrogen Economy* marks the start of a new era, characterized by greater energy independence and less environmental pollution. For hydrogen, there are many myths, and most important of which related to hydrogen as an unsafe and even dangerous fuel. Recent public interest in hydrogen has elicited a great deal of conflicting, confusing, and often ill-informed commentaries, therefore peer-reviewed white paper for both lay and technical readers was published in the United States by Amory Lovins (Lovins, 2003), documented primer on basic hydrogen facts, weighs competing opinions, and corrects twenty widespread misconceptions. United States Department of Energy in 2001 postulated key components while transition to Hydrogen Economy is necessary (United States Department of Energy, 2002):

- Hydrogen is "The Freedom Fuel";
- Hydrogen provides independence and an environmental choice;
- Hydrogen solves foreign oil dependency and improves the environment:
- Hydrogen is everywhere—"it's right in our backyard";
- A hydrogen economy includes other fuels and
- Hydrogen—it works (it is an ongoing business today);
- Hydrogen is safe;
- Hydrogen is a long-term energy solution;
- Hydrogen is the "man on the moon" equivalent for this generation.

With hydrogen technology information dissemination in Latvia works the Latvian Hydrogen Association (www.h2lv.eu) whose active members are students – authors of this study.There are several questionnaires used in research, our choice was evaluation scale 1 – 10, as it is more and more used for attitude evaluations.

2 Main results

University of Latvia as Organization should choose economically viable long term energy consumption by promoting sustainable development as well as science development. That is possible, renewable energy technologies will be integrated in the campus energy system. The faculties of natural sciences imply implementing innovative building technologies to provide with electricity Academic Centre of Natural Sciences, University of Latvia (include Biology, Chemistry, Geography and Earth Sciences – research laboratories, lecture-rooms, professor rooms etc., 200 researchers and professors, 2000 students. Social-economical survey via questionnaire was performed in February and March, 2012 to explore readiness of the society to use renewable technologies in the University of Latvia campus. Respondents are related to University of Latvia (students, professors, researchers, and possible future students, etc.). Faculties intended to locate in Academic Centre of Natural Sciences participated in the survey. In the survey were questions on respondent's environmental knowledge, attitudes, behaviour as well as information on socio-economic characteristics of respondents. Including, questions about the project acceptance, scientific value and safety issues. Some descriptive statistics (arithmetic mean, mode, median and indicators of variability) on question about information on knowledge about hydrogen as energy resource are reflected in table 1.

Table1. Main statistical indicators of responses on the question "*I am fully informed for hydrogen usability as energy resource"*

	Indicators	Values
N	Valid	364
	Missing	0
Mean		6,57
Std. Error of Mean		0,140
Median		7,00
Mode		10
Std. Deviation		2,678
Variance		7,171
Range		9
Minimum		1
Maximum		10

Source: Survey performed by authors in March 2012, n=364
Evaluation scale 0-10, where 0 – do not have information about issue, 1 fully disagree, 10 fully agree

As the survey results show (table 1), most of the respondents are very positive (with surprisingly high evaluations) for respondent knowledge level on hydrogen usability as energy resource has been evaluated above average (arithmetic mean = 6,57, with rather low variability – standard error of mean = 0,140, most of evaluations got the highest evaluation – 10, it is represented by mode (Mo = 10), half of respondents gave evaluation 7 or less, half of respondents gave evaluations at least 7 – it is characterised by median (Me = 7,00). It can be concluded that in average academia and students demonstrated positive attitude towards hydrogen energy and demonstrated good knowledge level about hydrogen technologies and are willing to accept and support technology implementation in University of Latvia Academic Centre of Natural Sciences (more in Dimants, *et al.* 2012*)*. For almost all statements most chosen evaluation was the highest – 10, characterised by mode, except for the statement "I am positively convinced for hydrogen energy safety", where the modal evaluation was 5. For this statement the full range of responses were covered (except 0, it means that all respondents had information on analysed issues and expressed their attitude. Table 2 reflects distribution of the answers by faculty for statement: *I am fully informed for hydrogen usability as energy resource*.

Table 2. Distribution of answers for statement: *I am fully informed for hydrogen usability as energy resource* by faculty

	Faculty represented					
	Faculty of Biology	Faculty of Physics and Mathematics	Faculty of Geography and Earth Sciences	Faculty of Chemistry	Riga Technical University	Total
1	6	0	0	3	0	9
2	3	2	3	5	0	13
3	4	1	8	6	0	19
4	8	2	6	4	0	20
5	10	5	12	8	0	35
6	7	0	8	7	1	23
7	14	6	5	9	0	34
8	7	9	6	11	0	33
9	5	13	4	9	0	31
10	14	10	5	14	0	43
Total	78	48	57	76	1	260

Source: Survey performed by authors in March 2012, n=260
Evaluation scale 0-10, where 0 – do not have information about issue, 1 fully disagree, 10 fully agree

Data of table 2 indicates that most informed on hydrogen usability as energy resource are in Faculty of Physics and Mathematics, less informed are in Faculty of Biology. Table 3 reflects distribution of the answers by gender for statement: *I am fully informed for hydrogen usability as energy resource*.

Table 3. Distribution of answers for statement: *I am fully informed for hydrogen usability as energy resource* by gender

	Gender				Total	
	Female	Share (%)	Male	Share (%)	Number	Share (%)
1	13	6,84	4	2,31	17	4,68
2	12	6,32	4	2,31	16	4,41
3	21	11,06	5	2,89	26	7,16
4	15	7,89	12	6,94	27	7,43
5	22	11,58	18	10,40	40	11,02
6	18	9,47	15	8,67	33	9,09
7	28	14,74	22	12,72	50	13,77
8	18	9,47	27	15,61	45	12,40
9	18	9,47	27	15,61	45	12,40
10	25	13,16	39	22,54	64	17,64
Total	190	100	173	100	363	100

Source: Survey performed by authors in March 2012, n=364
Evaluation scale 0-10, where 0 – do not have information about issue, 1 fully disagree, 10 fully agree

Data of table 3 indicates that male persons are much more informed on hydrogen as energy resource.

3 Conclusions

As the survey results show, most of the respondents are very positive (with surprisingly high evaluations) for respondent knowledge level on hydrogen usability as energy resource. It can be concluded that in average academia and students demonstrated positive attitude towards hydrogen energy and demonstrated good knowledge level about hydrogen technologies and are willing to accept and support technology implementation in University of Latvia Academic Centre of Natural Sciences. Also results indicate that most informed on hydrogen usability as energy resource are in Faculty of Physics and Mathematics, less informed are in Faculty of Biology. Interesting conclusion is that male persons are much more informed on hydrogen as energy resource.

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