Public acceptance of Hydrogen Fuel Cell applications in Europe

Christian Oltra (CIEMAT), Paul Upham (Leuphana Universität Lüneburg), Roser Sala (CIEMAT), Mònica Lores (CIEMAT), Uta Schneider (Fraunhofer ISI) and Elisabeth Duetschke (Fraunhofer ISI)

e-mail: Christian.oltra@ciemat.es

INTRODUCTION

- Among the alternative technologies to generate low-carbon heat and electricity and to replace fossil-fuel based vehicles, **residential fuel cells** and **hydrogen fuel cell vehicles** (FCEV) are receiving support towards commercialization in many countries.
- **Public and consumer acceptance** will likely play a role in the successful adoption of hydrogen and fuel cell applications.



OBJECTIVES

- To examine **public awareness**, **familiarity**, **perception** of **benefits and costs**, **global attitude** and **acceptance** of FCH technologies.
- To **identify key individua**l and **social determinants** of public awareness and acceptance.
- **To build a predictive model for acceptance** of FCH technologies

METHOD

- A nationally representative, self-administered cross-sectional survey was conducted in **seven European countries** (Germany, France, UK, Italy, Spain, Sweden and Slovenia) to gain insight into the public attitudes towards **two hydrogen applications**: residential fuel cells and hydrogen fuel cell vehicles.
- **Sample**: **7000 European citizens**, aged 16 and older. We particularly focus on **cross-country** and other group differences in self-reported **awareness** and **familiarity**, **global attitude** and **support** in relation to **mobile** and **static HFC applications**.

Distribution of the sample per country studied

Sample		BE (%)	FR (%)	DE (%)	NO (%)	SL (%)	ES (%)	UK (%)
N		1021	1022	1011	1033	1014	1034	1013
Sex (male)		47%	48%	49%	49%	49%	49%	52%
Age group	18-34	27%	28%	23%	28%	27%	29%	28%
	35-44	18	18	18	19	19	21	18
	45-54	19	17	19	18	18	18	17
	55+	36	36	40	35	35	32	37
Education	Primary	13%	24%	0.3%	8%	5%	8%	9%
	Secondary	46	25	75	40	60	31	30
	Tertiary (or higher education)	41	51	25	52	35	61	61
Size of place of residence	<2.000	9%	21%	8%	12%	27%	6%	12%
	2.000-20.000	46	33	31	29	38	19	23
	20.001-199.999	32	27	29	35	18	31	32
	200.000-1.000.000	7	10	19	17	14	23	17
	>1.000.000	5	9	13	6	2	21	16

- The questionnaire included items specifically developed by the research team and drawing partly on a technology acceptance model describing the causal links among the attitudinal elements that directly and indirectly affect technology acceptance (Huijts, Molin and Steg, 2012)*.

*Huijts, N. M. a., Molin, E. J. E., & Steg, L. (2012). Psychological factors influencing sustainable energy technology acceptance: A review-based comprehensive framework. Renewable and Sustainable Energy Reviews, 16(1), 525–531. http://doi.org/10.1016/j.rser.2011.08.018

RESULTS

- Attitudes to HFCs vary across countries and socio-demographic groups. We also examine the psycho-social direct and indirect determinants of public acceptance of home fuel cells and hydrogen fuel cell vehicles.

Acceptance of Residential fuel cell units

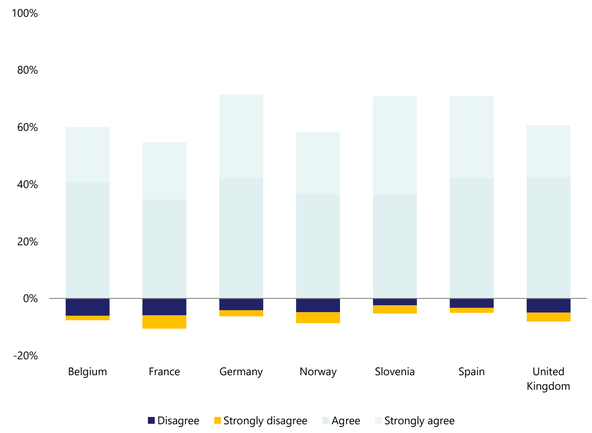


Figure 1. *Acceptance of residential hydrogen fuel cells (% of respondents in the seven countries that would like to have a hydrogen fuel cell system in their home)*

- There is a **higher level of acceptance** in **Germany**, **Spain** and **Slovenia** (71% in the three countries), and a **lower level** in **France** (55%), **Norway** (58%), **Belgium** (60%) and **UK** (60%). In these four countries, more than 30% of respondents are undecided about home HFCs and around 10% are not willing to have one installed in the future.

Acceptance of hydrogen fuel cell electric vehicles (HFCEV)

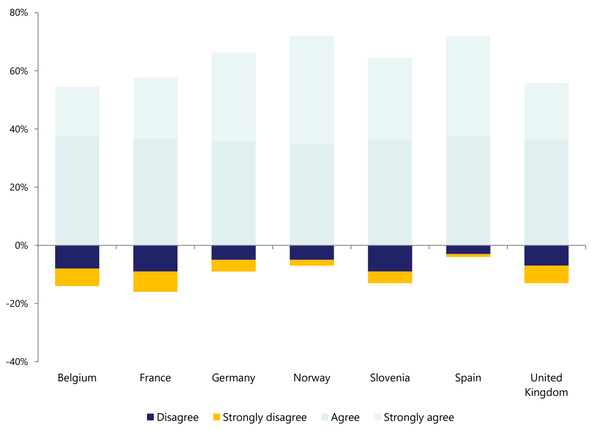
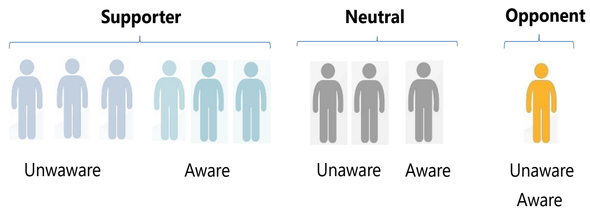


Figure 2. *Acceptance of HFCEVs (% of respondents in the seven countries that would like to have a HFCEV)*

- There is a **higher level of acceptance** in **Norway** and **Spain** (72%), and a **lower level** in **Belgium** (55%), **UK** (56%), and **France** (58%). In these three countries, more respondents are undecided about hydrogen cars (around 30%) and between 13 and 15% are not willing to have one in the future.

Supporters and opponents



- Respondents can be categorized into three groups: supporters, neutrals and opponents.
- In the full sample, **6 out of 10 respondents can be considered supporters of HFCs applications**, 3 out of 10 as neutral and fewer than 1 out of 10 respondents as opponents to HFC applications.
- The **highest percentage of supporters** is found in **Slovenia**, **Spain** and **Germany**, and the **lowest** is found in **United Kingdom**, **France** and **Belgium**.

Socio-demographic correlates of public attitudes towards HFC applications

- Male respondents with university degrees living in cities with more than one million inhabitants and living comfortably with current income had, on average, the most favourable profile of acceptability.

The effect of information and prior attitudinal orientations

- There is a non-significant increase in favourable attitudes between the uninformed evaluation of HFCs and the informed evaluation of domestic HFC units and HFCEV).
- **The effect seems to differ between opponents and supporters**: as opponents become more informed about HFC applications, their evaluation of the technology gets worse

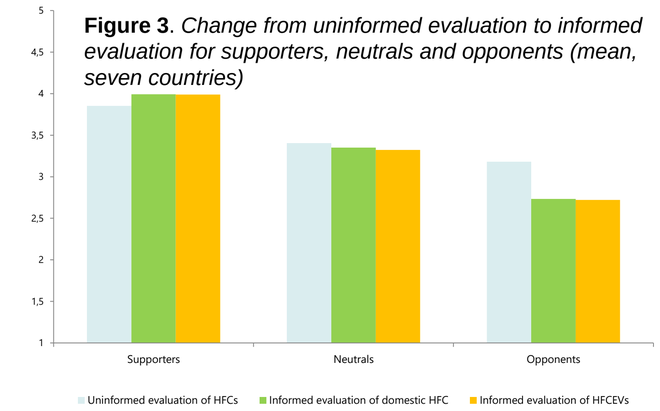


Figure 3. *Change from uninformed evaluation to informed evaluation for supporters, neutrals and opponents (mean, seven countries)*

- A path analysis was estimated to examine the direct and indirect determinants of acceptance of HFCEVs

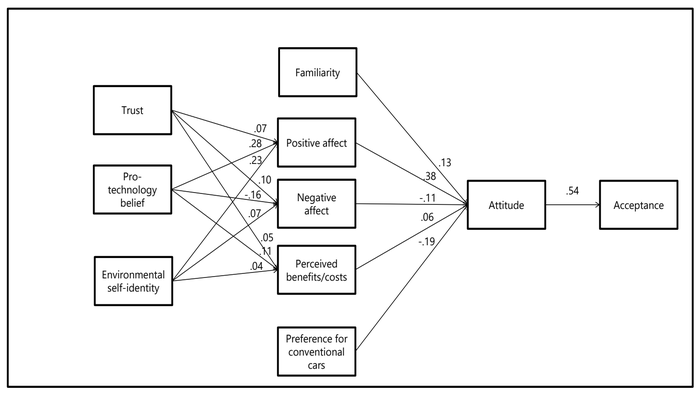


Figure 4. *Summary of path analysis on acceptance of home hydrogen fuel cell (standardized coefficients β)*

CONCLUSION

- **Less than half of the population** is **aware of the existence of hydrogen and fuel cell technologies** in the context of energy production.
- Public awareness is significantly **lower for residential applications** and higher for hydrogen fuel cell vehicles.
- The **level of familiarity** with both applications is **low** (less than 10% of respondents consider themselves familiar).
- The majority of the population have a **positive initial attitude towards HFC technologies**. The label associated to hydrogen and fuel cells seems to invoke **positive affects** and beliefs among respondents.
- After processing relevant information, **the majority of respondents accepts** and **supports** the adoption of residential fuel cells and HFCEVs.

This project has received funding from the Fuel Cells and Hydrogen Joint Undertaking (FCH-JU) under grant agreement Nº 621228