



**STORHY**  
Train-IN 2006

## Session 3.3: Demonstration and Exhibition Lectures

Public Acceptance of Pressure  
Hydrogen Applications in  
Transportation

Dr. H. Schnieder

25<sup>th</sup> – 29<sup>th</sup> September 2006  
Ingolstadt



## 3.3 Demonstration & Exhibition



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### CV – Dr. H. Schnieder

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I have been working with DaimlerChrysler's (formerly Daimler-Benz) Society and Technology Research Group in Berlin since 1981.

Before joining Daimler-Benz, I have served as project engineer at Borsig AG, Berlin, in the Power Plant and Industrial Refrigeration Plant Department.

I hold a doctorate (Dr.-Ing.) in Chemical Engineering from the TU Berlin, where I had specialized in Fluidized Bed Technology, and a diploma in Mechanical Engineering and Energy Technology from the same university.

## 2.4 Pressure Storage Systems



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- Public Acceptance of Pressure Hydrogen Applications in Transportation,

Dr. H. Schnieder (DC)

### **Abstract:**

Fuel cell vehicles, fuelled by hydrogen and equipped with high pressure hydrogen tanks, are supposed to be mainstream sometime in the future. All of the relevant automobile companies are working on the development of these vehicles.

One crucial point for the successful market introduction is the acceptance of the high pressure storage technology by the potential drivers and the public in general.

This study shows, that drivers of fuel cell vehicles have little or no concern about this innovative technology, provided they have been educated adequately.



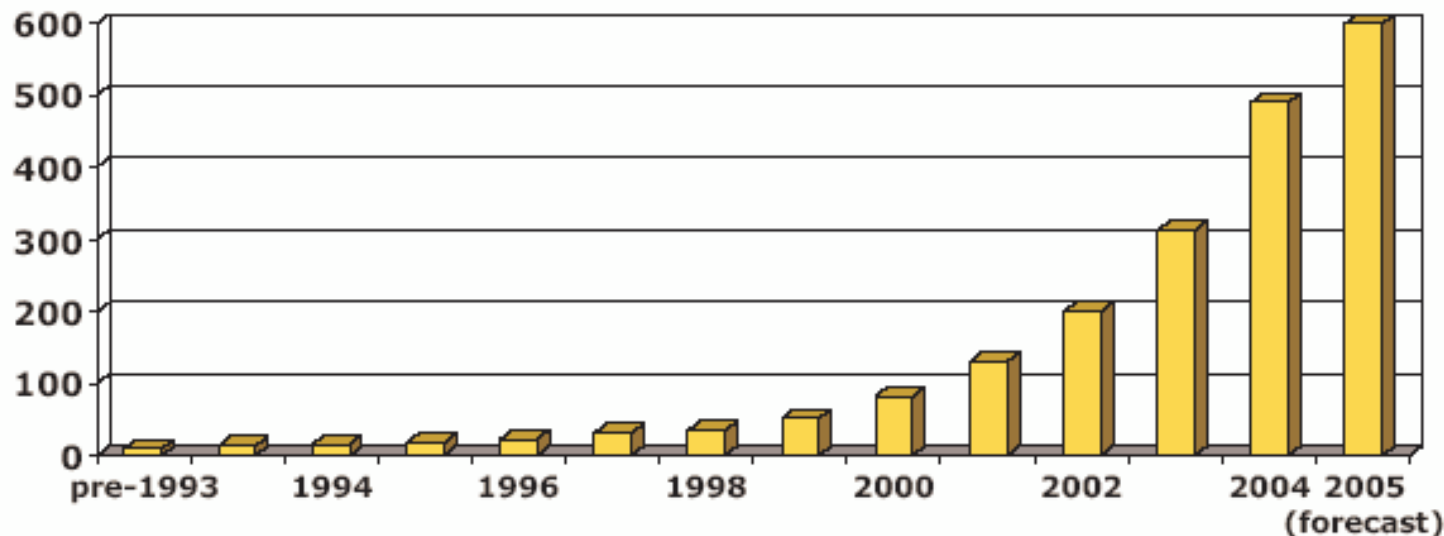
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- Objectives and background of this study
- DaimlerChrysler's activities in the development of fuel cell vehicles
- Sample and methodology
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# Objectives and Background

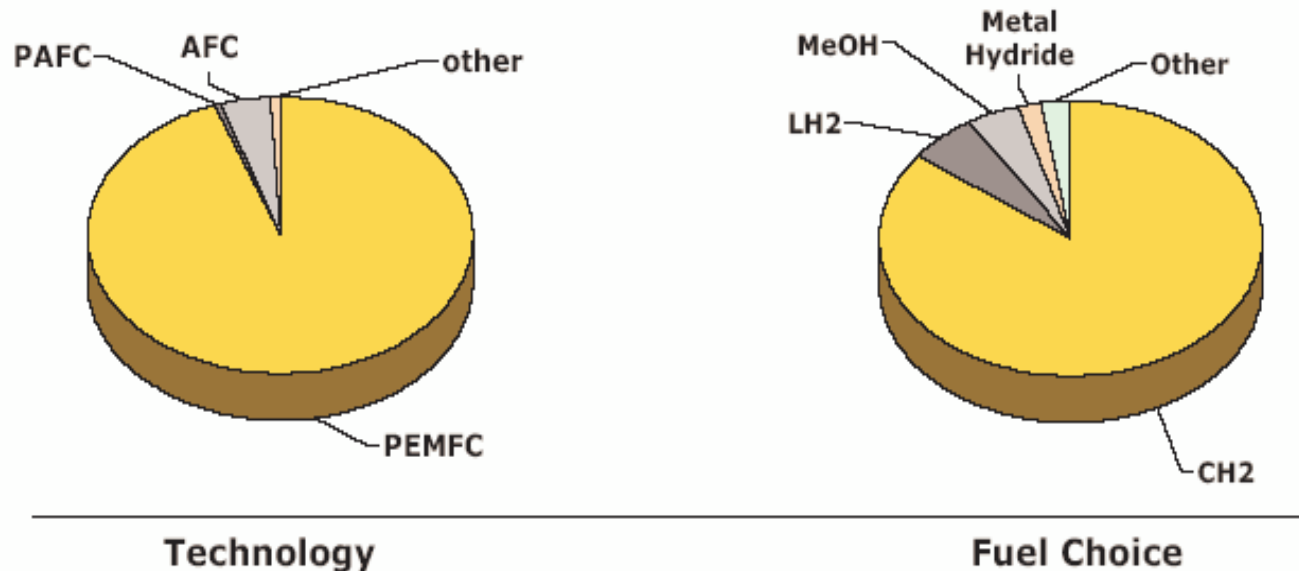


## Light duty vehicles built, cumulative



- Almost all of the relevant automotive OEM are working on the development of fuel cell vehicles.
- The total number of fuel cell light duty vehicles most probably has hit the mark of 600 globally by the end of 2005.

# Objectives and Background



- Most of these vehicles are powered by PEM fuel cells fuelled with compressed gaseous hydrogen stored in high-pressure vessels.
- The current standard is 35 MPa storage, but to enhance vehicle performance or cruising range, respectively, 70 MPa storage is targeted as the next step.
- Public awareness and customer acceptance are certainly the crucial points for the future of this technology.

# Objectives and Background



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- DaimlerChrysler has been working on the development of fuel cell vehicles since more than a decade.
- Currently a fleet of 60 F-Cell (A-Class) fuel cell vehicles is being tested under everyday operating conditions in co-operation with several fleet partners.
- Focal points for this project are California, Michigan, Singapore, Tokyo, as well as Stuttgart and Berlin.

# Clean Energy Partnership (CEP)



- CEP is the German National Demonstration Project for hydrogen application in transportation, as part of the German sustainability strategy. (elapse time: december 2007).
- CEP is located in Berlin. Hence, main location of the F-Cell Germany project is Berlin. Second spot for Germany is the Stuttgart / Nabern (DC/MB headquarter activities).

## F-Cell Project Berlin:



- 5 - 10 F-Cells.
- Operated from Mercedes-Benz Dealership Berlin „Mercedes World“.
- Organisation of partnerships and communication activities.
- Platform for service & maint.



**Legally binding commitment of DC to join CEP with F-Cell vehicle!**

**CEP provides:**

- H<sub>2</sub> Infrastructure
- Service & mainten.
- Comm. platform

## Clean Energy Partnership:



### Mobility

- BMW
- DaimlerChrysler
- Ford
- GM/Opel
- BVG
- Volkswagen AG

### Infrastructure

- ARAL
- Hydro
- Linde
- Vattenfall Europe
- Total

# Objectives and Background



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This study aims at

- gathering information from drivers of fuel cell vehicles regarding the vehicle in general, the high pressure tank and the re-fuelling procedure,
- analyzing the experiences of operation under everyday conditions,
- generating information for the further development and optimisation of fuel cell vehicles and their components,
- supporting the development and dissemination of the re-fuelling infrastructure,
- investigating the public awareness of this technology and finding ways to improve the drivers' and public acceptance.



## Sample

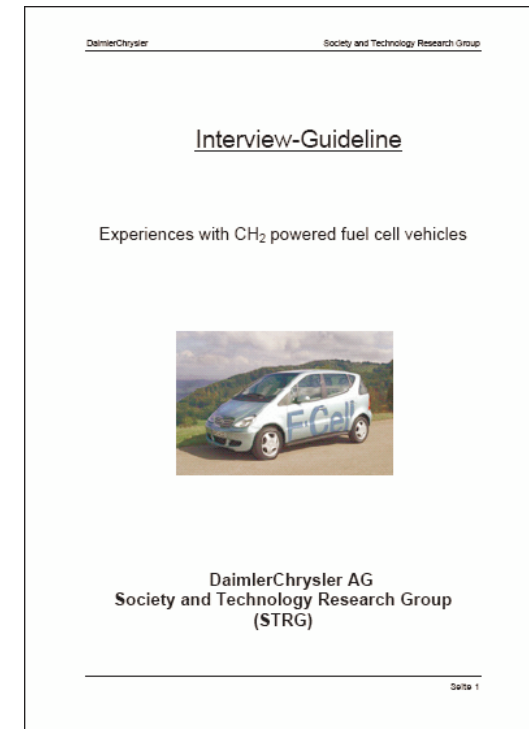
20 fuel cell vehicle drivers of the Berlin F-Cell fleet

11 drivers of CNG vehicles, mostly driving instructors or taxi drivers (Control Group)

## Methodology

Guided Interviews with a questionnaire covering

- Drivers' general impression of the vehicle
- Driving, handling, re-fuelling
- H<sub>2</sub> safety
- Comparison with Diesel vehicles
- Comparison of F-Cell and CNG vehicles
- Market readiness, market potential
- Influential factors for market entry



## Analysis of Interview Results (Here: Focus on Fuel Cell Vehicle)



As the interviews have been executed as a mixture of a set of key questions and a guided casual conversation, the deliverables were a set of measurable, ranked statements, as well as a valuable collection of personal opinions and assessments.

### General remarks about the sample

The interviewees drive the fuel cell vehicle only occupationally (fleet vehicle)

16 of the 20 drivers were male, only 4 were female

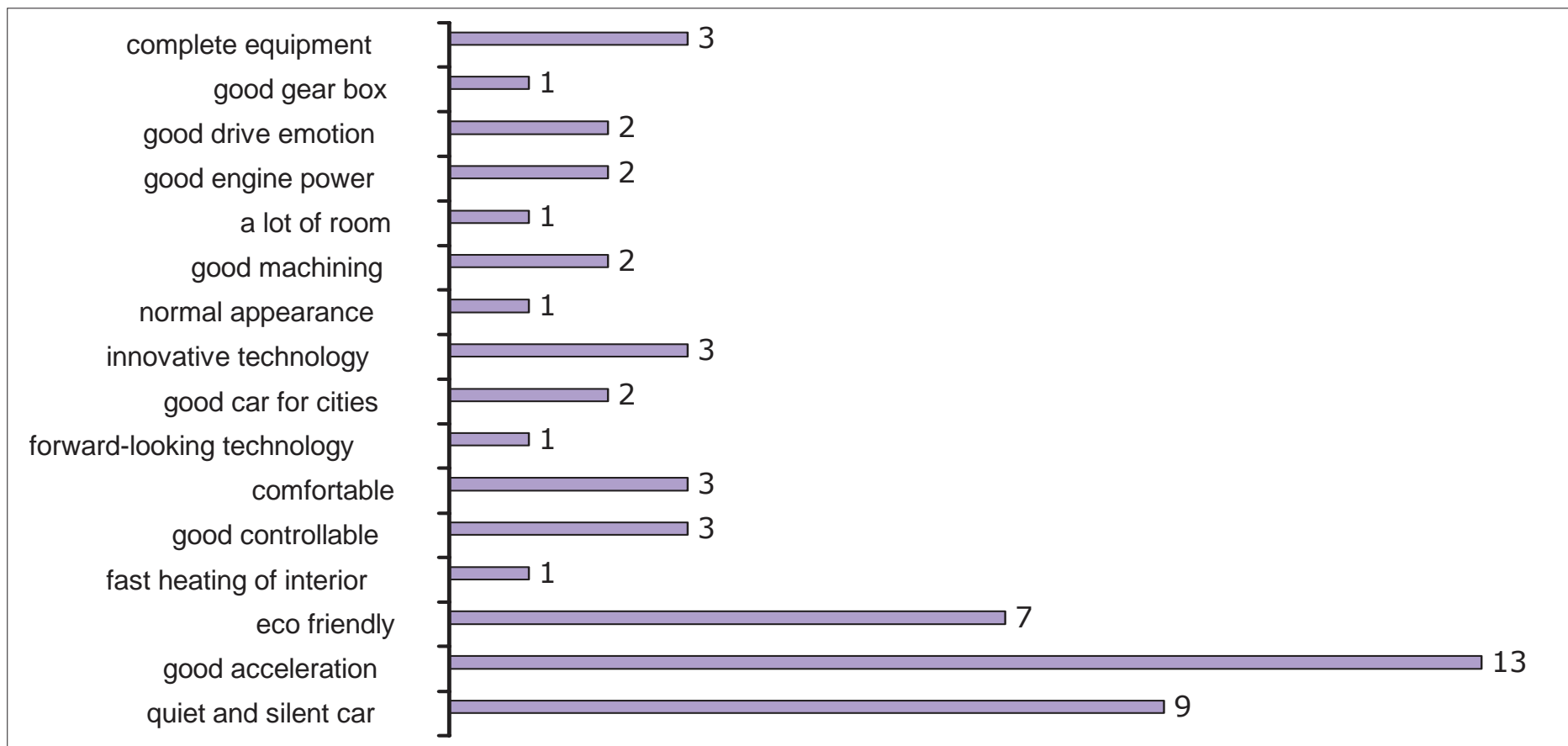
The average age was 43 years



# Analysis of Interview Results



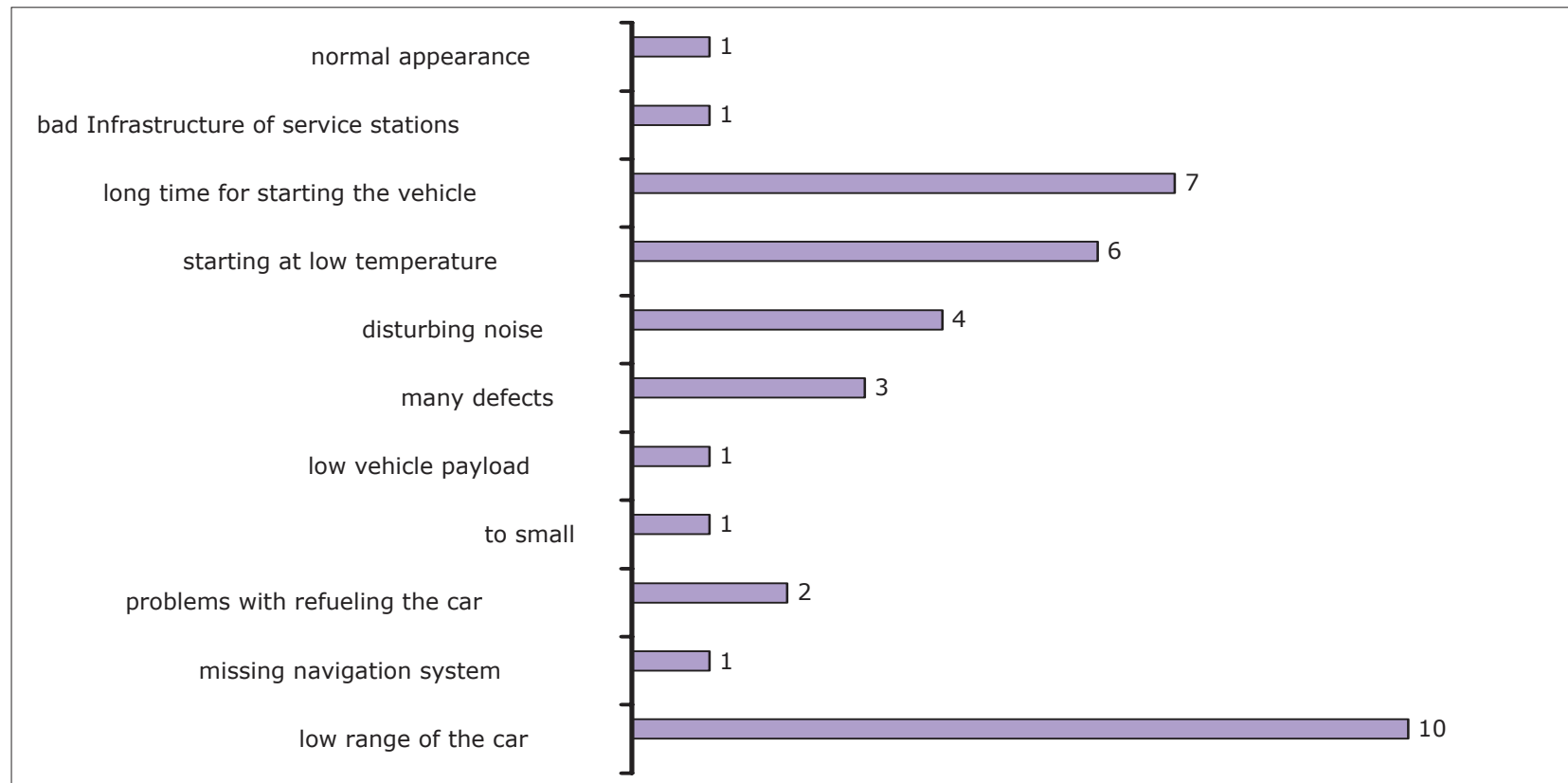
Question: Please explain briefly what you **like** particularly in your vehicle





# Analysis of Interview Results

Question: Please explain briefly what you **dislike** particularly in your vehicle



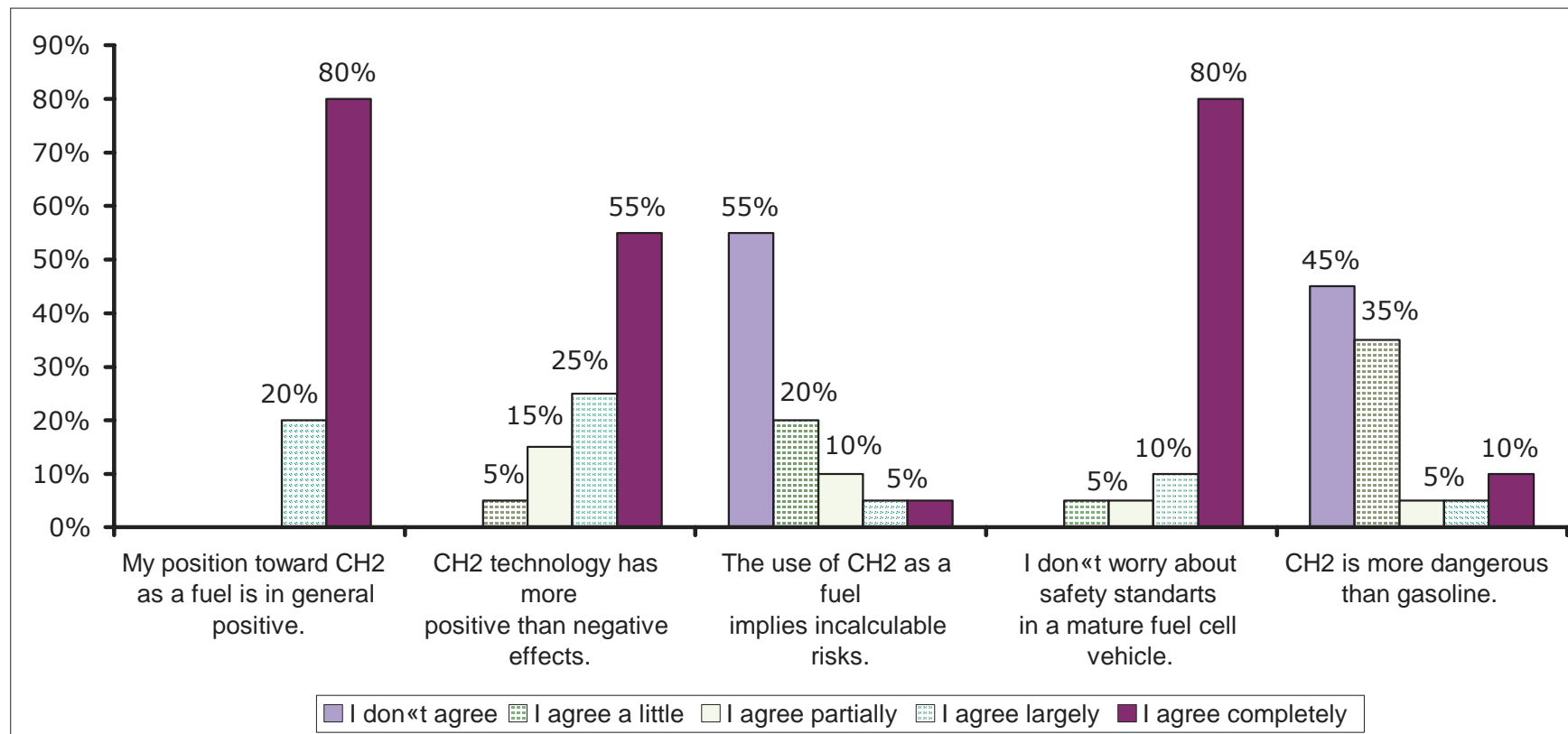
Main Problems: Low cruising range and starting procedure



# Analysis of Interview Results



Question: What is your opinion about the following aspects of CH<sub>2</sub>?



Very few objections to safety aspects of compressed hydrogen

# Analysis of Interview Results



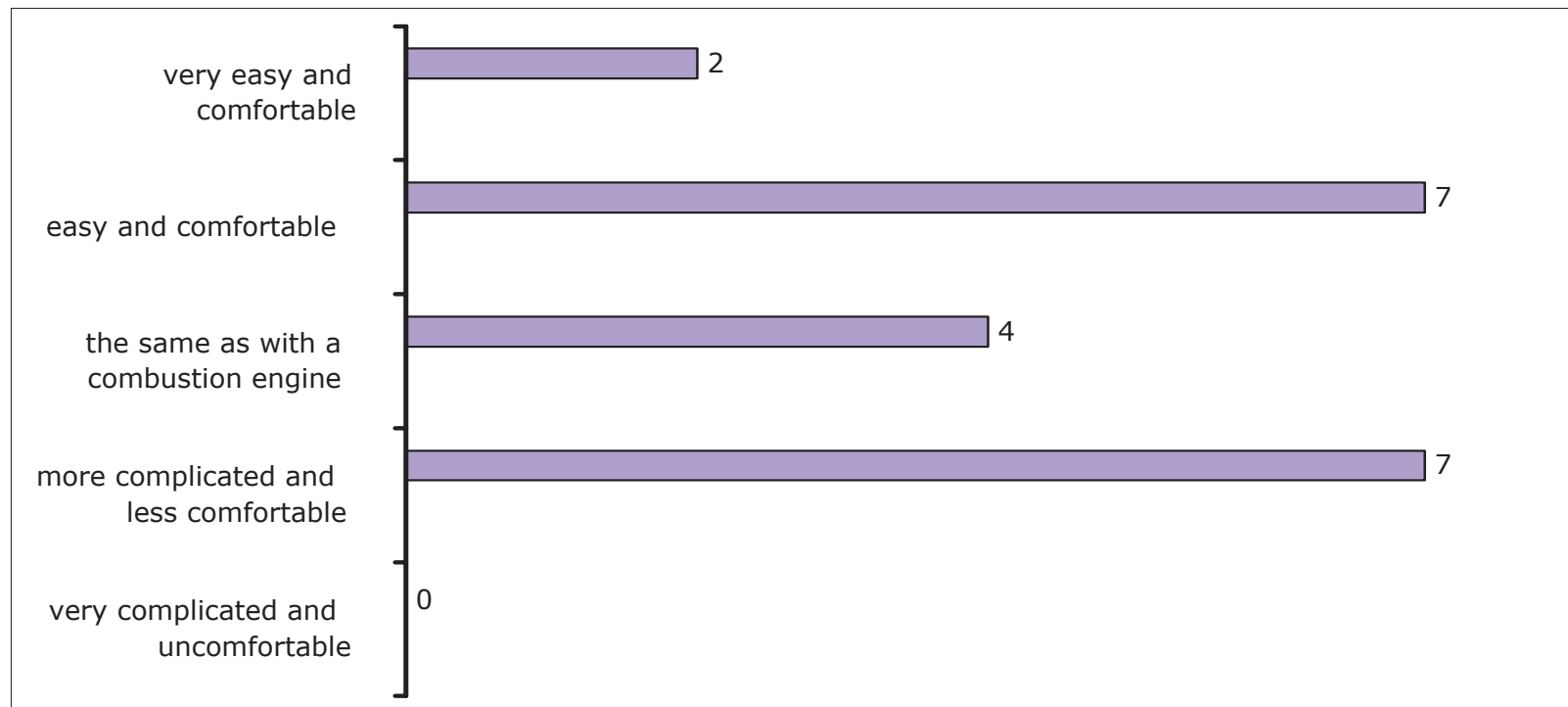
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- The analysis shows that a majority of the drivers of fuel cell vehicles has a positive impression of the vehicle.
- Likewise they see more positive than negative characteristics in the fuel cell technology and in hydrogen as a fuel.
- Concerning the necessary safety standards in the case of a market introduction there are very little doubts among the surveyed persons.
- They trust fully and completely in the car manufacturers and their safety precautions.
- Moreover they trust into the co-operation between car manufacturers and the technical control authorities such as TÜV and DEKRA.

# Analysis of Interview Results



Question: How would you estimate the fueling process compared to a conventional vehicle?

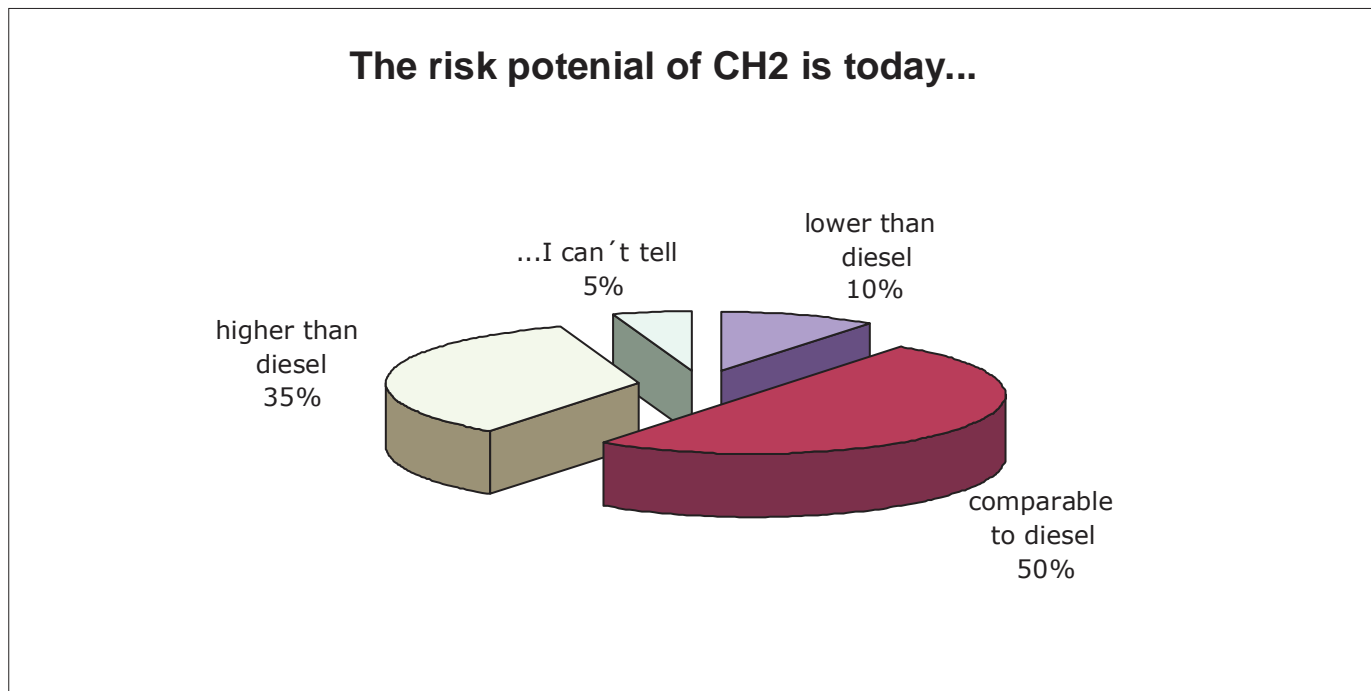


Problems occurred mainly from the design of the re-fuelling station (long ways etc.), not from the re-fuelling process as such

# Analysis of Interview Results



Question: Please compare CH2 as a fuel with diesel!



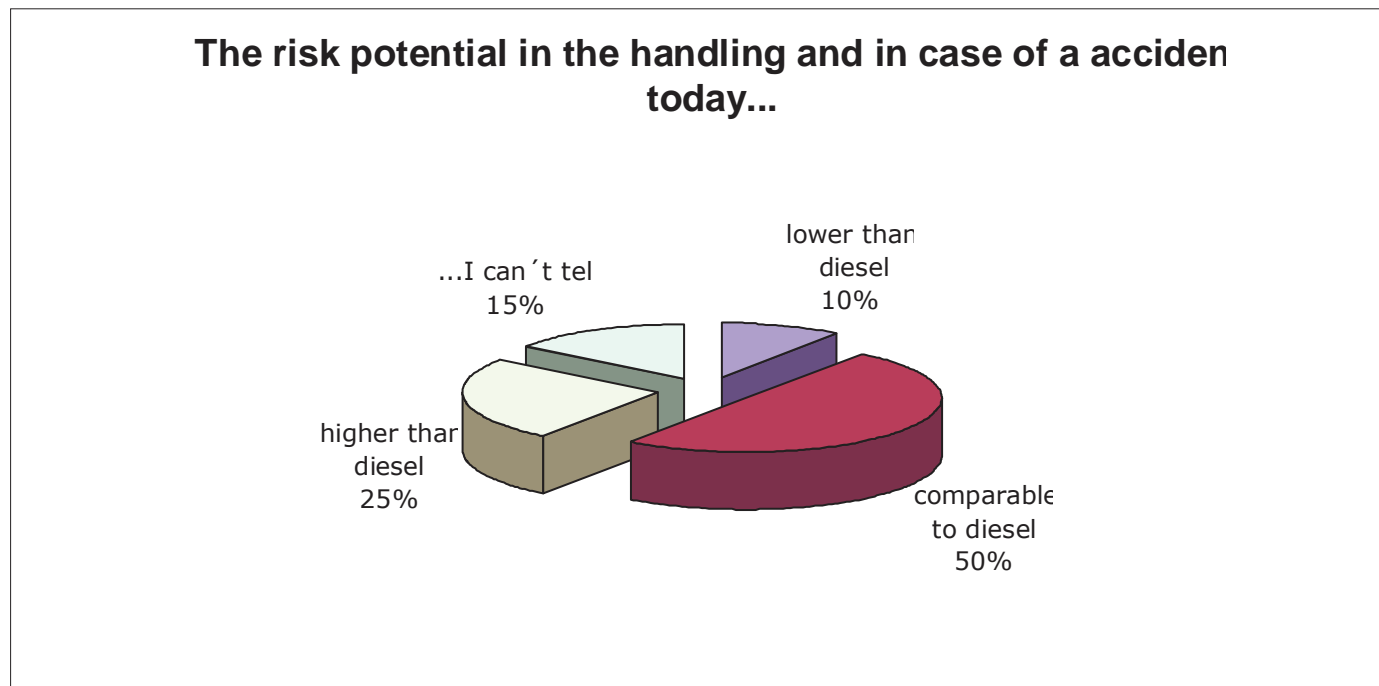
\* Questioned if they had this attitude from the outset the majority of drivers answered negatively. Their initial uncertainty about the security of hydrogen diminished over the test period with the experience.

1/3 believes, that the use of compressed hydrogen is more dangerous than diesel fuel, nearly 2/3 think that the risk potential of hydrogen is equal to that of diesel fuel or even lower. \*

# Analysis of Interview Results



Question: Please compare a fuel cell vehicle with a diesel powered vehicle!



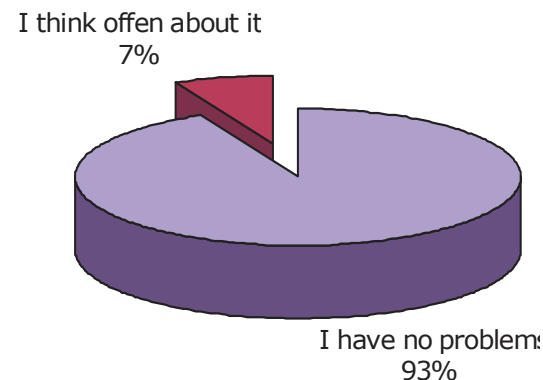
The risk estimations of the vehicle as a whole are very similar to that of the fuels

# Analysis of Interview Results



Question: How does it feel to drive a vehicle with a high pressure tank?

**Do you have any concerns regarding the high pressure tank in your car?**



One driver's statement:  
„At my first few rides, I often thought about the fuel tank. But now it's quite normal for me.“

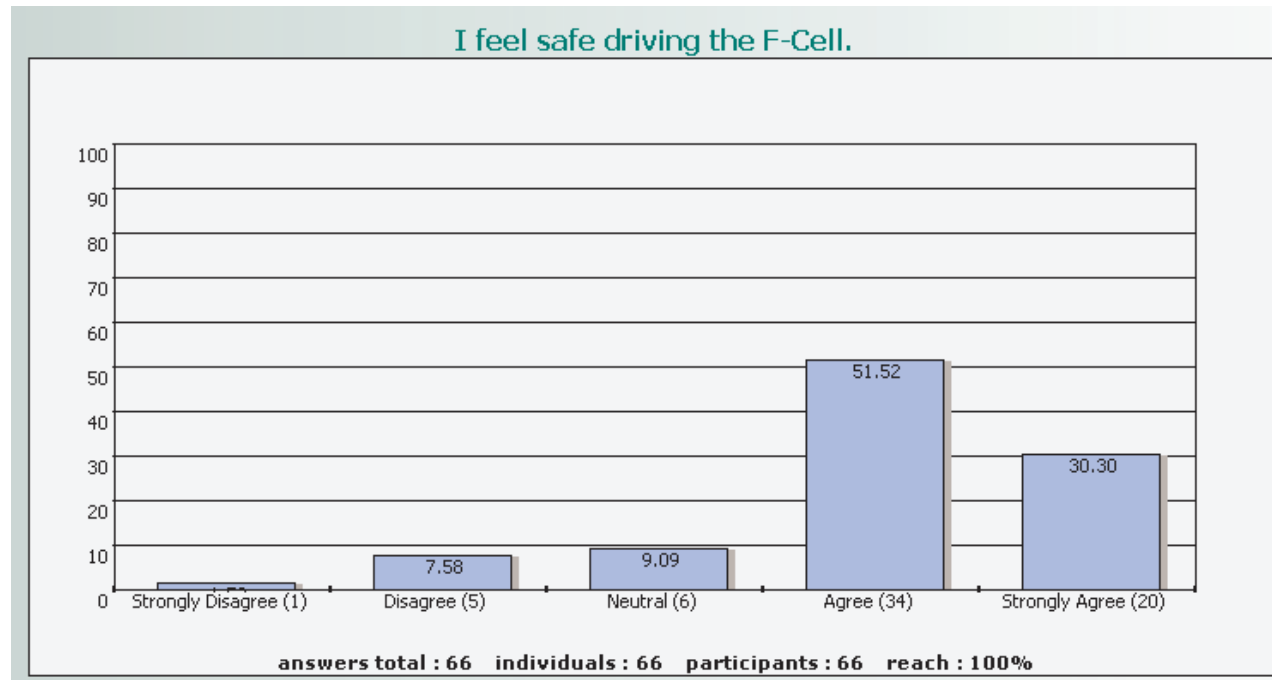
For 93 percent it is not a problem to drive a vehicle with a high pressure tank. They justify their trust with the deep insight into the complex safety system of the fuel cell vehicle they were given during their training courses and when talking with the experts from DaimlerChrysler.

# Verifying Results from the California Fuel Cell Partnership



Meanwhile we obtained very similar results from California, where DaimlerChrysler is running a test fleet of 32 F-Cell vehicles in co-operation with several corporate and institutional partners.

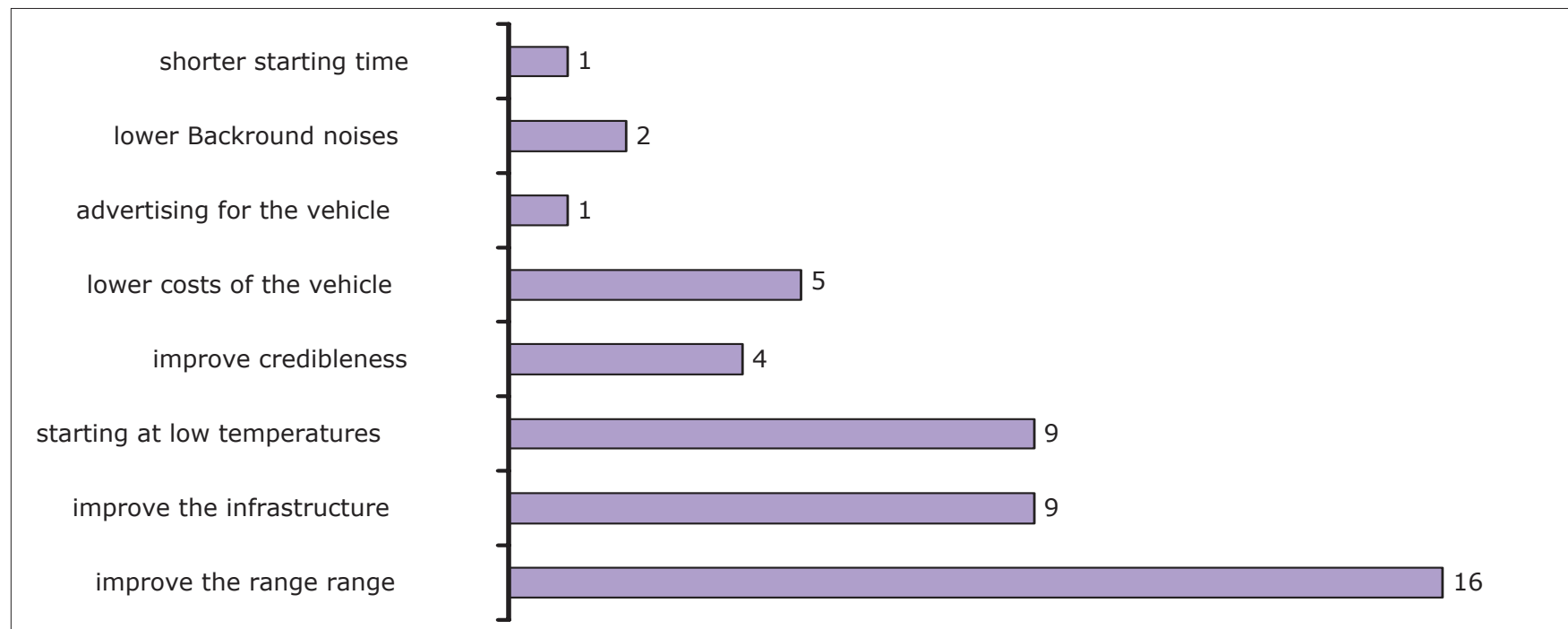
From the total of 66 drivers interviewed, 54 stated that they feel safe driving the F-Cell vehicle, while only 6 answered that they had concerns about the safety and another 6 were neutral.



# Analysis of Interview Results



Question: What has to be done around the vehicle to be ready for the market entry?



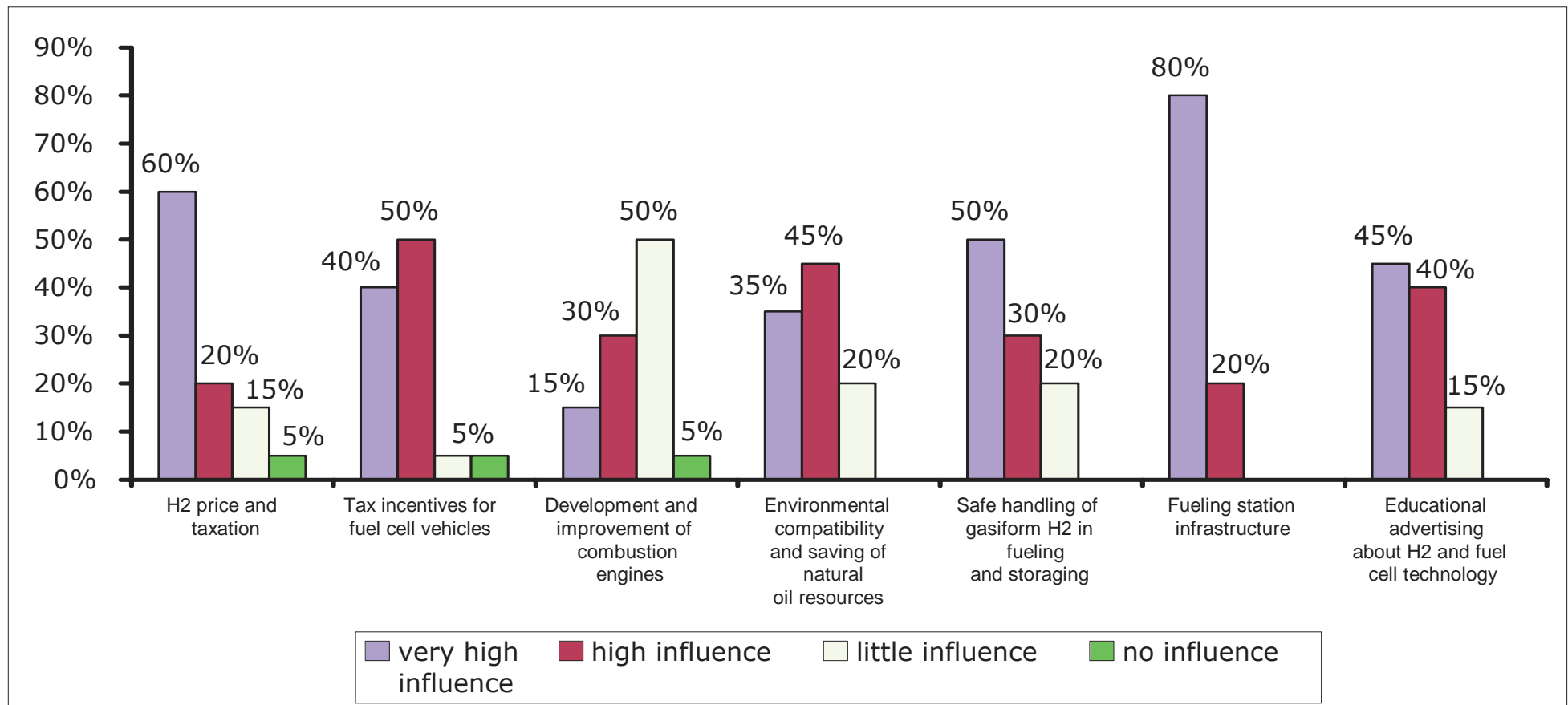
The main obstacle for market introduction is the poor cruising range. So the step to 70 MPa storage seems to be indispensable.



# Analysis of Interview Results

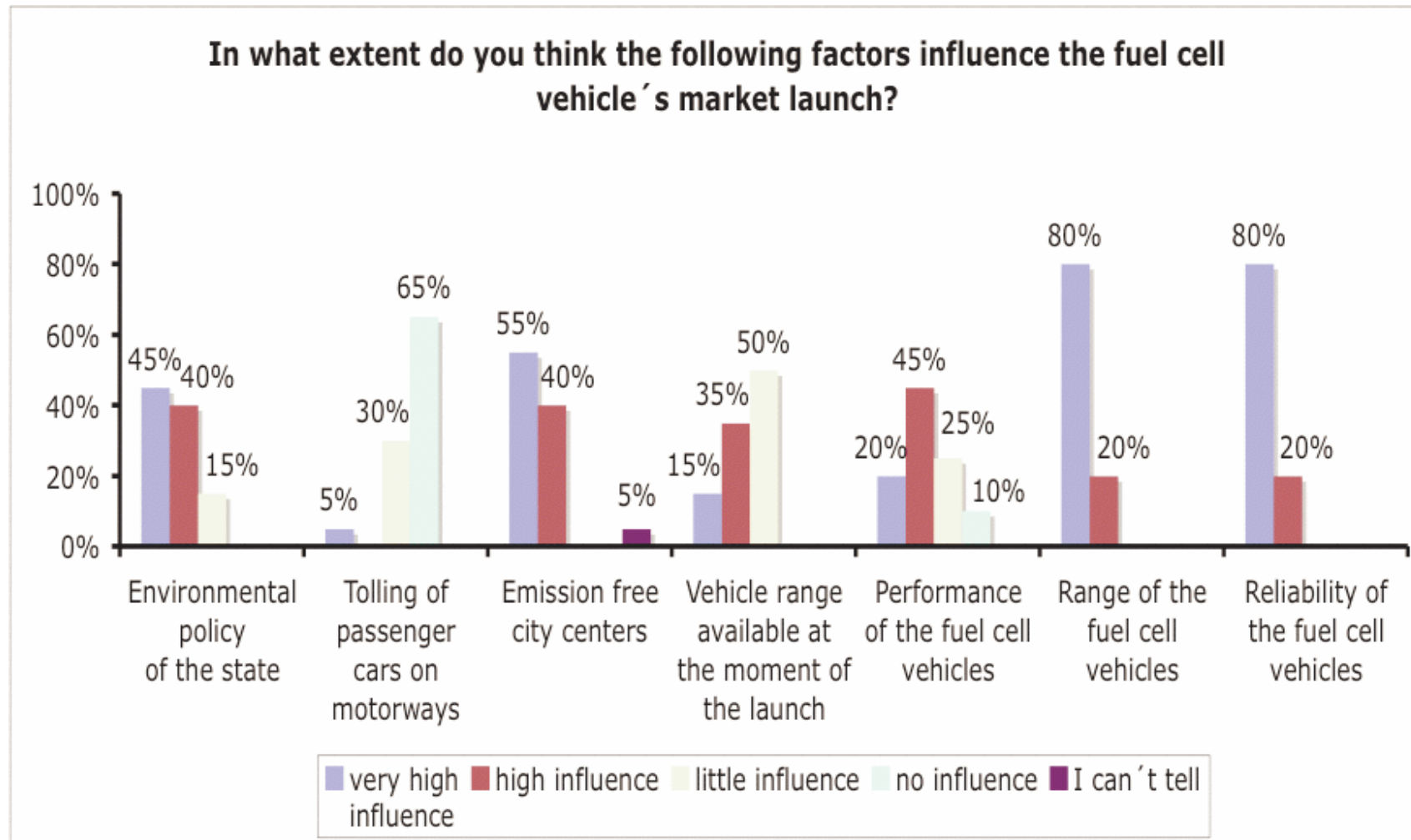


Question: In what extent do you think the following factors influence the fuel cell vehicle's market launch?





# Analysis of Interview Results





## What has to be done to improve the acceptance of hydrogen high pressure storage?

- Implement high level safety standards and certificates (DEKRA, TÜV, etc.)
- Improve the cruising range of the vehicles to meet customer needs
- Improve the re-fuelling process
- Intensify the communication of the technology, its advantages and safety measures to win public confidence
- Improve technology education

# Public Acceptance of Pressure Hydrogen Applications in Transportation



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**Thank you for your attention!**



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