Institute of Transport Economics
Norwegian Centre for Transport Research

# Societal challenges and barriers to hydrogen fuel adoption in Norwegian transport

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SH2IFT Workshop

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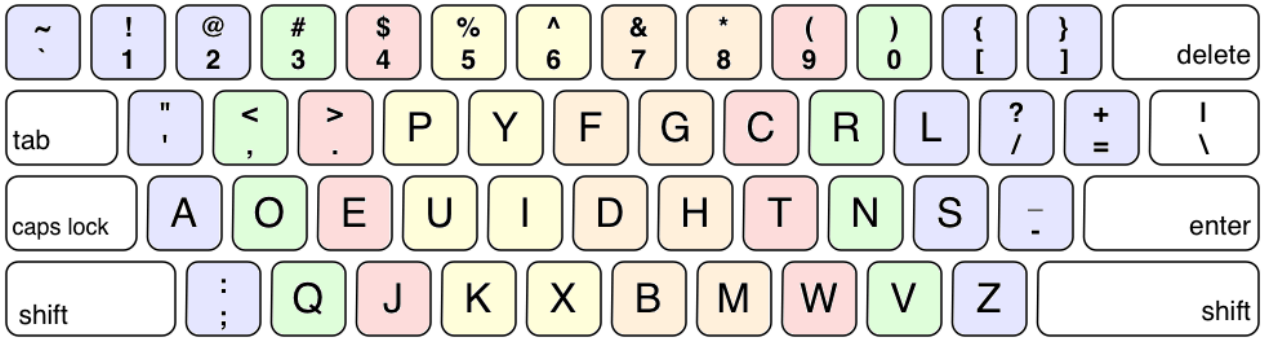
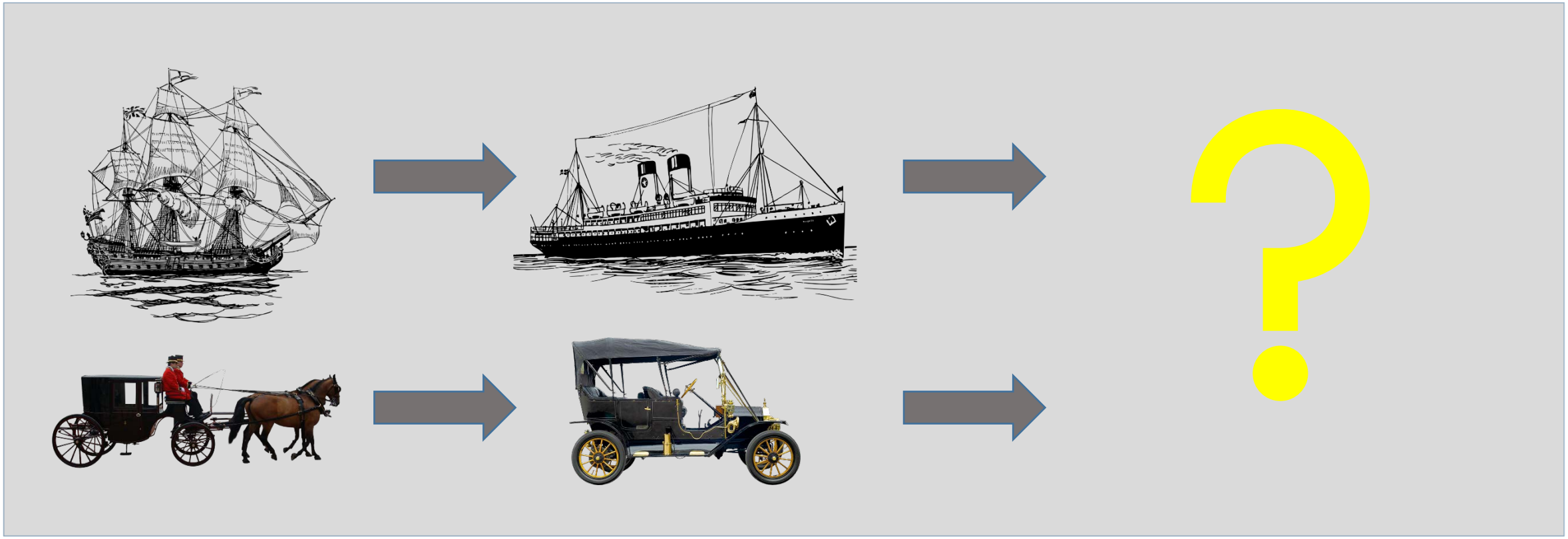
# Inventions vs innovations




## Socio-technical Transitions

"not just changes in technology but also changes in consumer practices, policies, cultural meanings, infrastructures, and business" (Geels 2018)

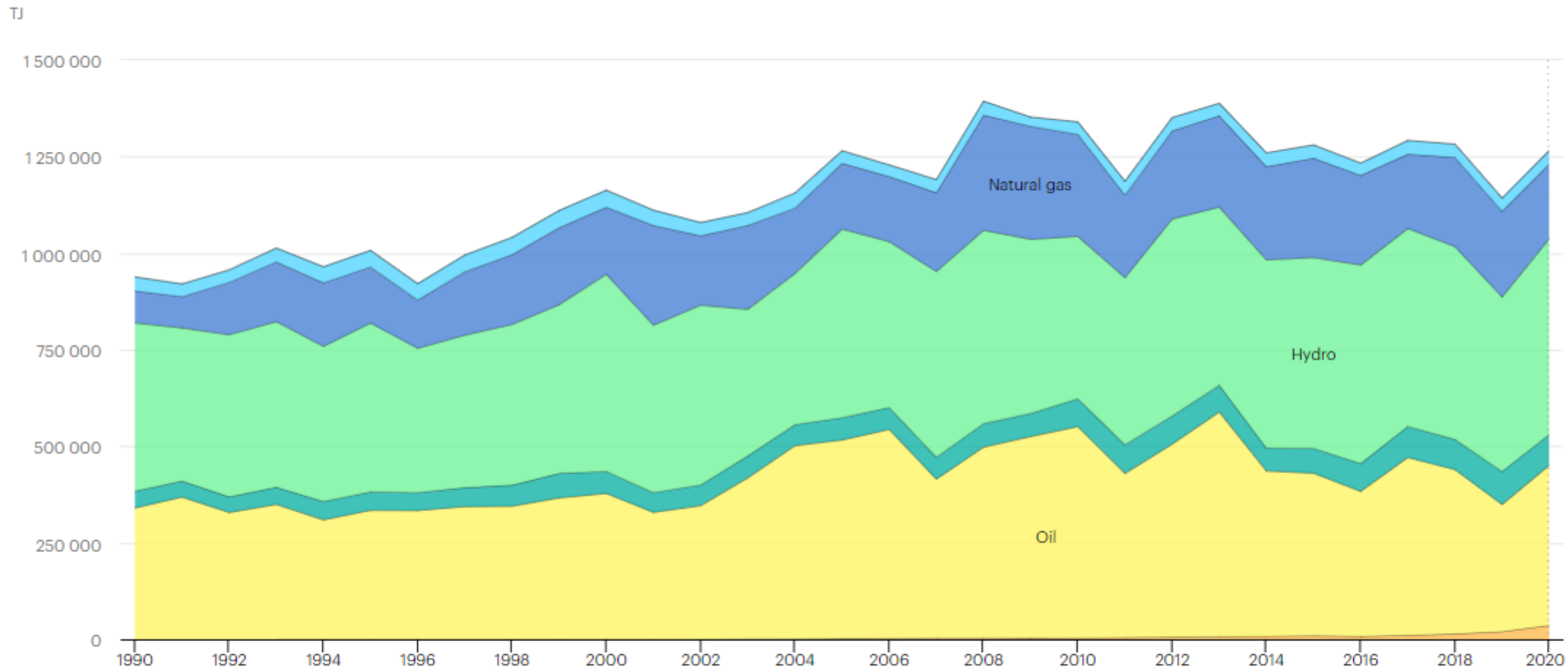


# Work Package 1: Societal factors

What are the drivers and barriers to the adoption of hydrogen fuel in Norwegian transport?

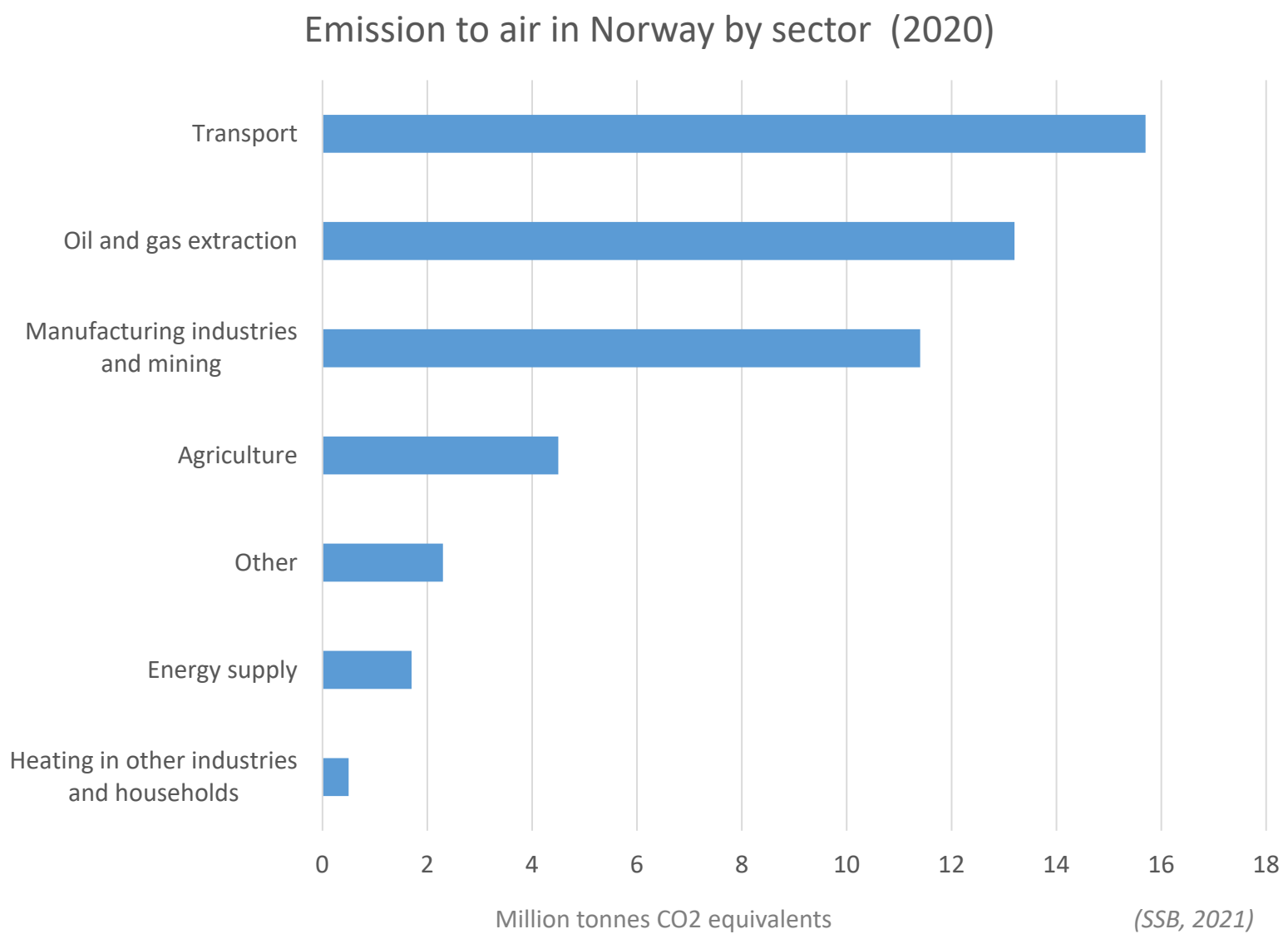
- Context
- Public perception
- Type of application
- Competing/complementary technologies

Total energy supply (TES) by source, Norway 1990-2020






Coal Natural gas Hydro Biofuels and waste Oil Wind, solar, etc.


Emission to air in Norway by sector (2020)
Transport
Oil and gas extraction
Manufacturing industries and mining
Agriculture
Other
Energy supply
Heating in other industries and households
0
2
4
6
8
10
12
14
16
18
Million tonnes CO2 equivalents
(SSB, 2021)

Hydrogen fuel in Norwegian transport by segment: passenger cars, bus, truck, maritime

| Segment | No. Vehicles | Notes |
|---|---|---|
|  | ≈200 | BEV competition<br>HRS incident<br>Market supply |
|  | 5 | Problems with tender and scale<br>Timing of commercialization |
|  | 4* | Rigorous demand articulation process<br>Cross-segment compatibility |
|  | 2* | Clear coordination and steering<br>Groundwork for new standards |

# Survey Design

Carried out online in Feb. 2021

Nationally representative

Recruited from Kantar panel (N≈40,000)

N=2117

Response rate: 38.1%

Men (48.8%) Women (51.2%)

**Part 1**

Comparative questions for multiple powertrains (hydrogen, battery, petrol, diesel, natural gas)

**Part 2**

Hydrogen specific questions

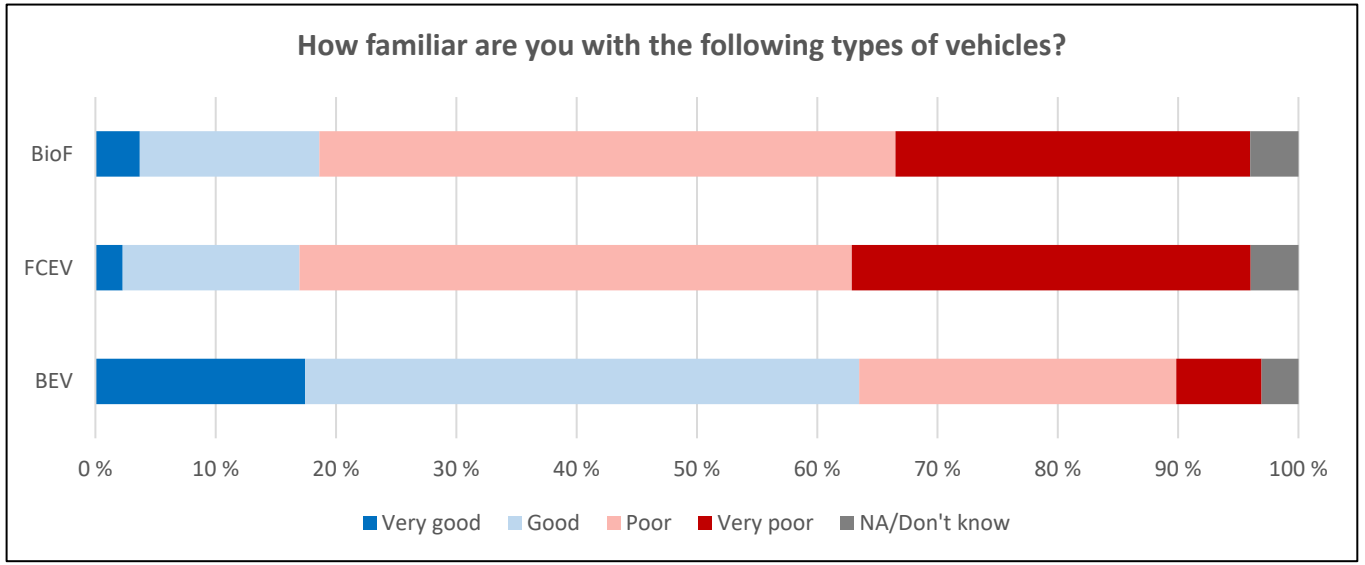
Elements of public perception:

- **Awareness/knowledge**
- **Perceived sustainability**
- **Perceived safety**
- Willingness to pay
- Economic development
- Green-Blue-Grey
- Gas-Liquid-Ammonia

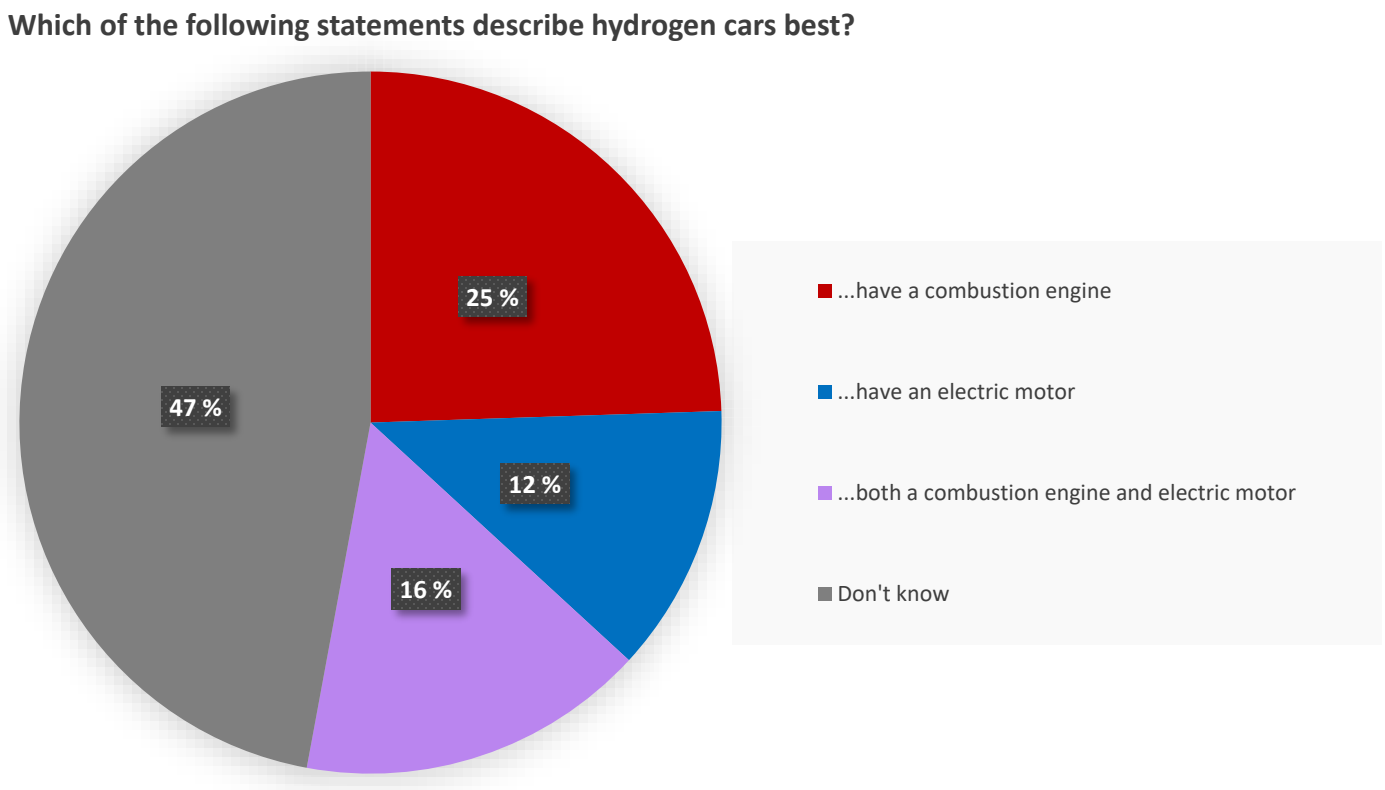
# Awareness

18 percent of London residents had heard of both hydrogen vehicles and fuel cells vehicles (O'Garra et al., 2005)

About 85 percent of Stavanger residents "claimed to have heard about the development of hydrogen as a fuel for vehicles" (Thesen & Langhelle 2008)



# Awareness


Which of the following statements describe hydrogen cars best?
25 %
12 %
16 %
47 %
...have a combustion engine
...have an electric motor
...both a combustion engine and electric motor
Don't know

# Perceived sustainability

“Support derived from perceived environmental benefits - greenhouse gas and air pollution reduction.” (Garrity 2004)

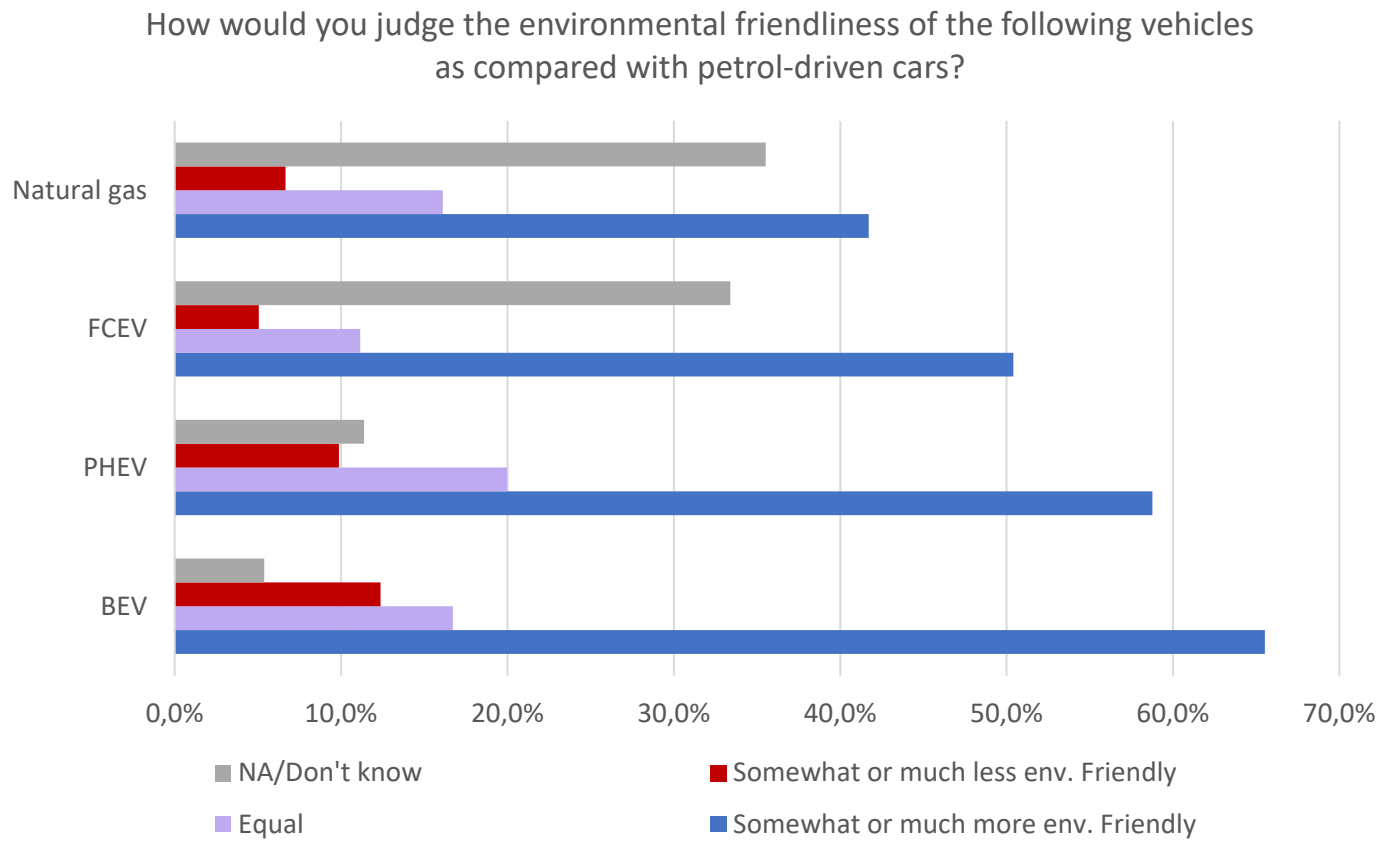
“People mostly derive their assessment that the technology is environmentally friendly from the fact that its only product is water…It is also considered a “natural” element.” (Zimmer & Welke 2012)

“our results indicate that publics associate hydrogen with positive environmental performance” (Bögel et al. 2018)

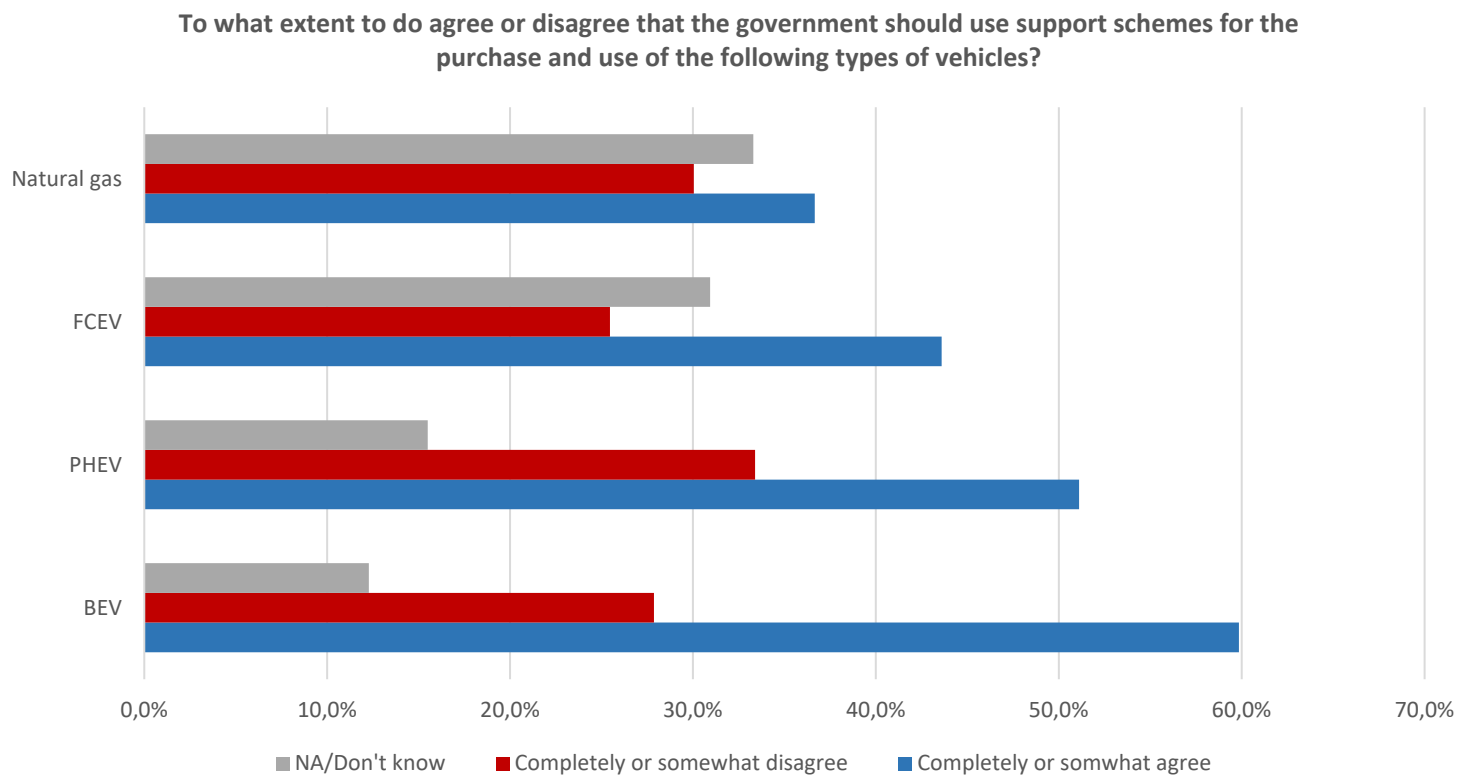
“most people support the development of hydrogen energy because of the belief that hydrogen is a clean energy” (Chen et al. 2016)

“75% of the respondents described the use of hydrogen as environmentally sound.” (Irabarren 2016)

# Sustainability



# Perceived sustainability and government support



# Perceived safety/risk

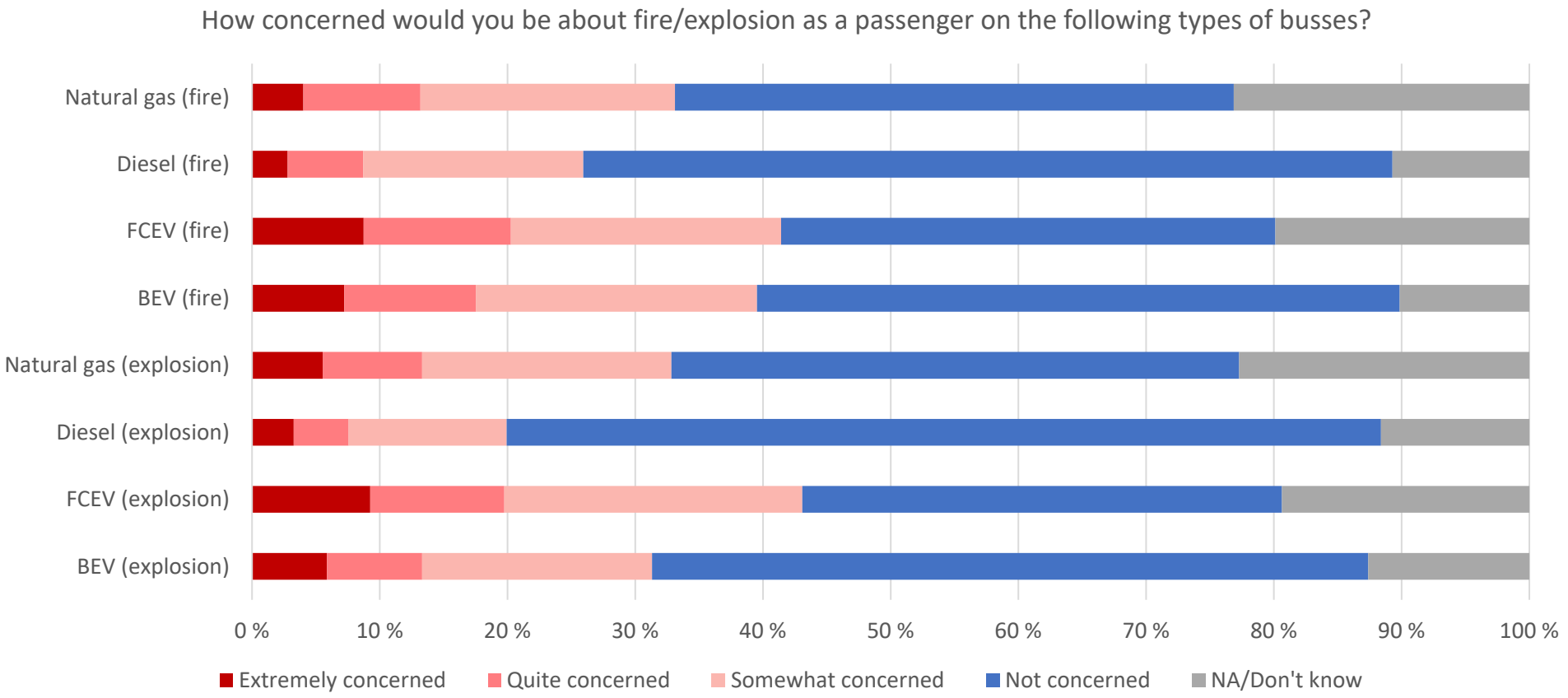
"'if it [the FCEV taxi] weren't safe it wouldn't be licensed." (Mourato et al., 2004)

concerns over hydrogen safety "were not overwhelmingly strong…most people wanted to be given much more detailed information…" (Flynn et al., 2008).

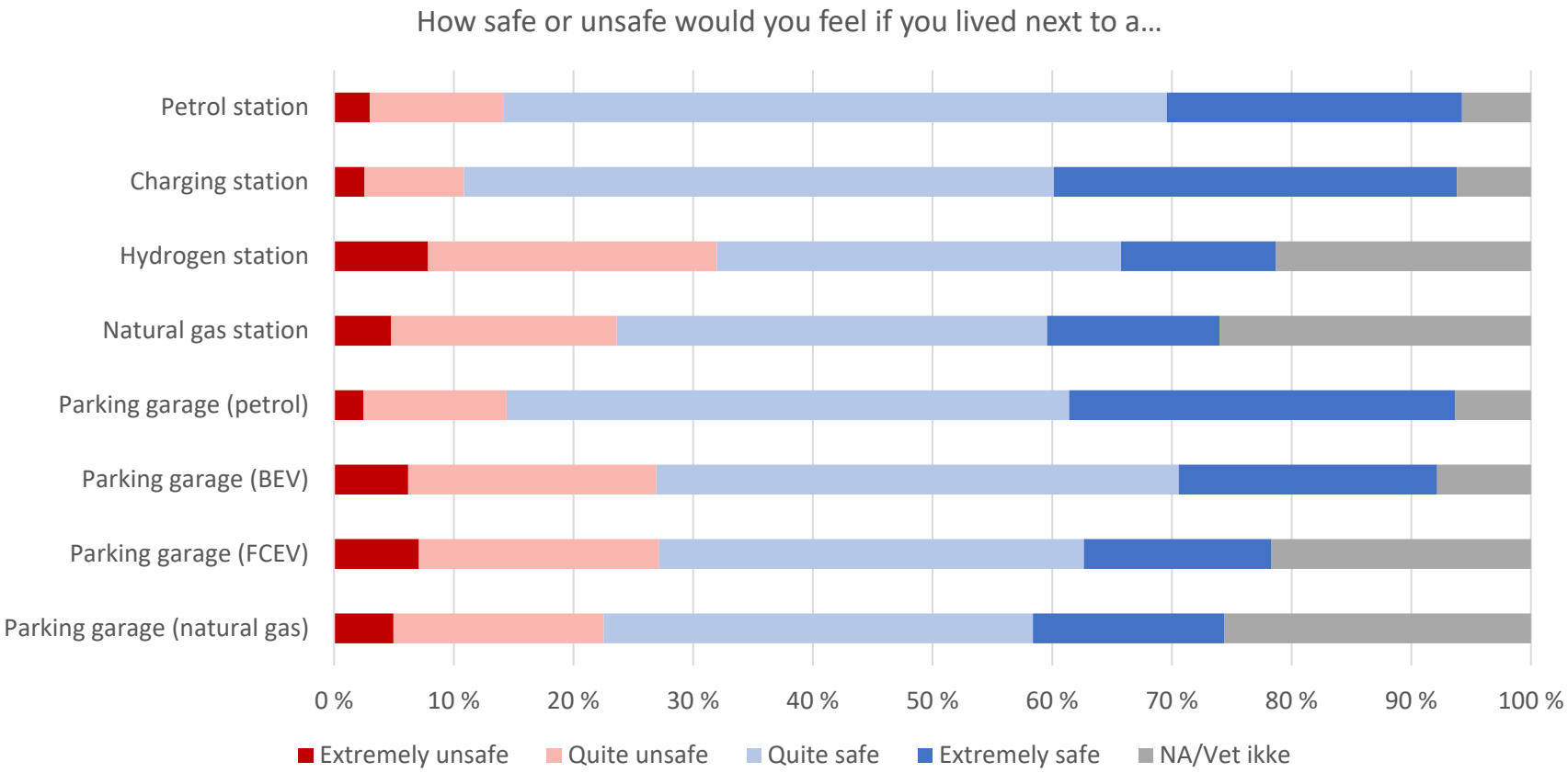
"safety concerns about hydrogen mobility in Denmark seems not to be a barrier to the propensity of the public to purchase a FCEV" (Apostolou and Welcher 2020)"

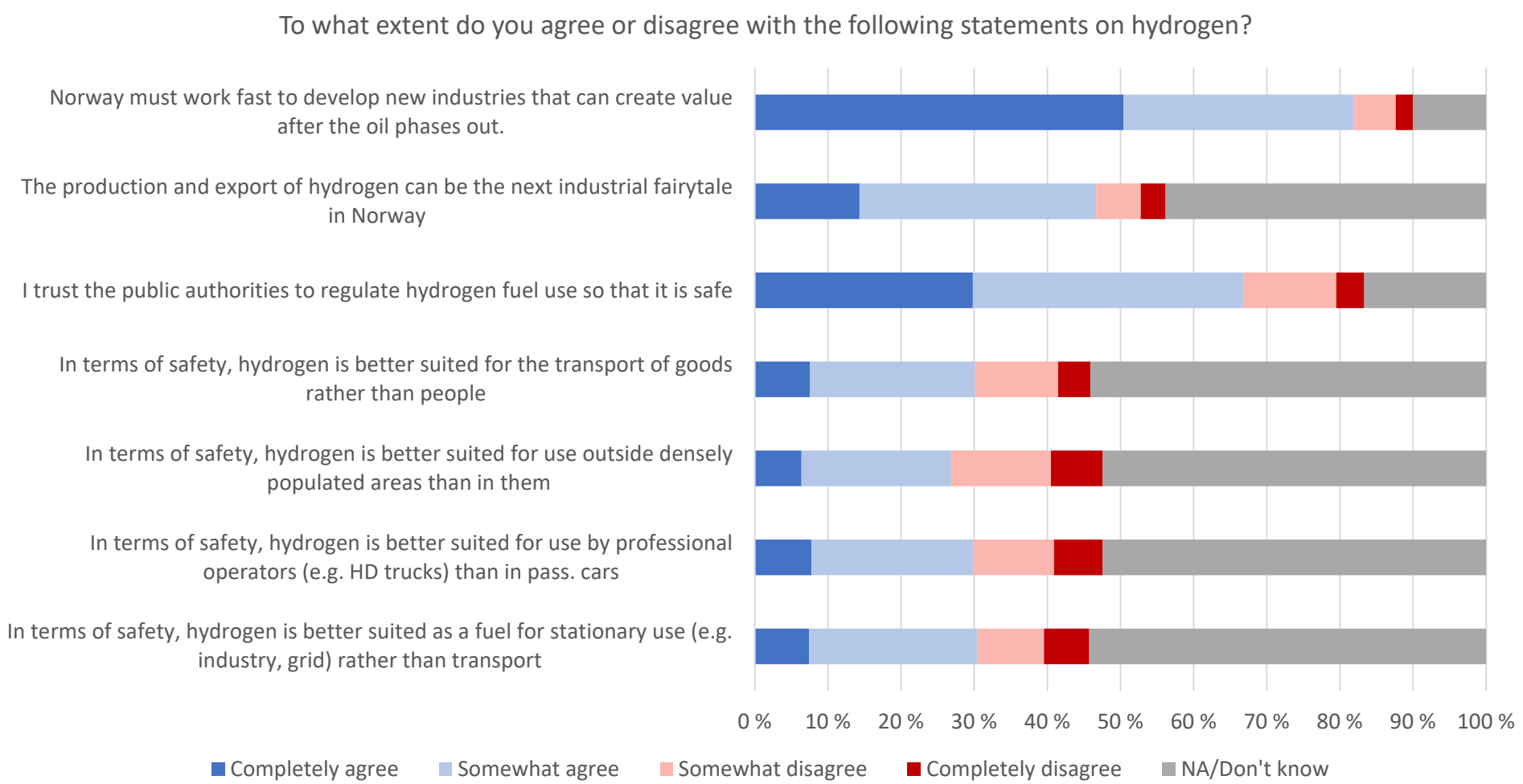
"…an accident during the introduction phase of a new technology, albeit small, can disproportionately damage its uptake" (Slovic et al., 1984 as cited in Roche et al., 2010)

# Perceived Safety



# Perceived Safety




To what extent do you agree or disagree with the following statements on hydrogen?
Norway must work fast to develop new industries that can create value after the oil phases out.
The production and export of hydrogen can be the next industrial fairytale in Norway
I trust the public authorities to regulate hydrogen fuel use so that it is safe
In terms of safety, hydrogen is better suited for the transport of goods rather than people
In terms of safety, hydrogen is better suited for use outside densely populated areas than in them
In terms of safety, hydrogen is better suited for use by professional operators (e.g. HD trucks) than in pass. cars
In terms of safety, hydrogen is better suited as a fuel for stationary use (e.g. industry, grid) rather than transport
0 %
10 %
20 %
30 %
40 %
50 %
60 %
70 %
80 %
90 %
100 %
Completely agree
Somewhat agree
Somewhat disagree
Completely disagree
NA/Don't know

# Overall fear of hydrogen fuel

| | | Safety concerns for hydrogen fuel | | | |
|---|---|---|---|---|---|
| | | Bus fire | Bus explosion | Residential HRS | Residential H2 Parking |
| | Awareness of the 2019 HRS explosion | + | + | + | + |
| Control variables | Age 45+ | + | + | + | + |
| | Male | - | - | - | - |
| | Higher education | - | - | - | - |
| | Proximity | - | - | - | - |
| | Car use | + | + | + | + |
| | Bus/tram use | - | - | + | + |
| | Ferry use | + | + | - | + |
| | Trust gov H2 reg | - | - | - | - |

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# Takk!

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