

# Perceptions of hydrogen production for maritime applications

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# Research questions and motivation

- **RQ1** To what extent does type of hydrogen production (i.e., green, blue and grey) influence public perceptions of hydrogen as an alternative energy source?
- **RQ2** Are these views influenced by people's attitudes towards environmental protection and climate change, political preferences, or socio-demographic backgrounds?

## **Why important?**

- Policymaking: Are people supportive (or not)? What influences their (lack of) support?
- Public support and engagement
  - Energy transition projects can be met with public resistance (windmills)
  - A first step for engaging the public is to understand their preferences.

# Perceptions of low-carbon energy technologies (e.g., Peterson et al 2015)

- Individuals usually express positive perceptions toward low-carbon energy technologies, especially renewable energy technologies, such as solar and wind.
- Less positive reactions towards biomass and low-carbon fossil fuel technology such as natural gas; technologies to enable control of fossil fuel emissions, such as carbon capture and storage (CCS); and nuclear energy.

# Perceptions of hydrogen (e.g., Ricci et al 2008; Achterberg et al 2010)

- Individuals are generally supportive of hydrogen technology.
- Environmental concern, trust in technology, and increased knowledge/awareness increase hydrogen acceptance.
- The higher educated, males, and the young have stronger support for hydrogen technology.
- However, hydrogen appears to be a largely unknown and unfamiliar issue, which raises doubts about the effectiveness and appropriateness of using survey-based approaches to assess public opinions about and attitudes towards hydrogen.

**By focusing on hydrogen production, we limit this problem, as we expect most people to have informed opinions about environmental consequences of using renewable energy as opposed to fossil fuels.**

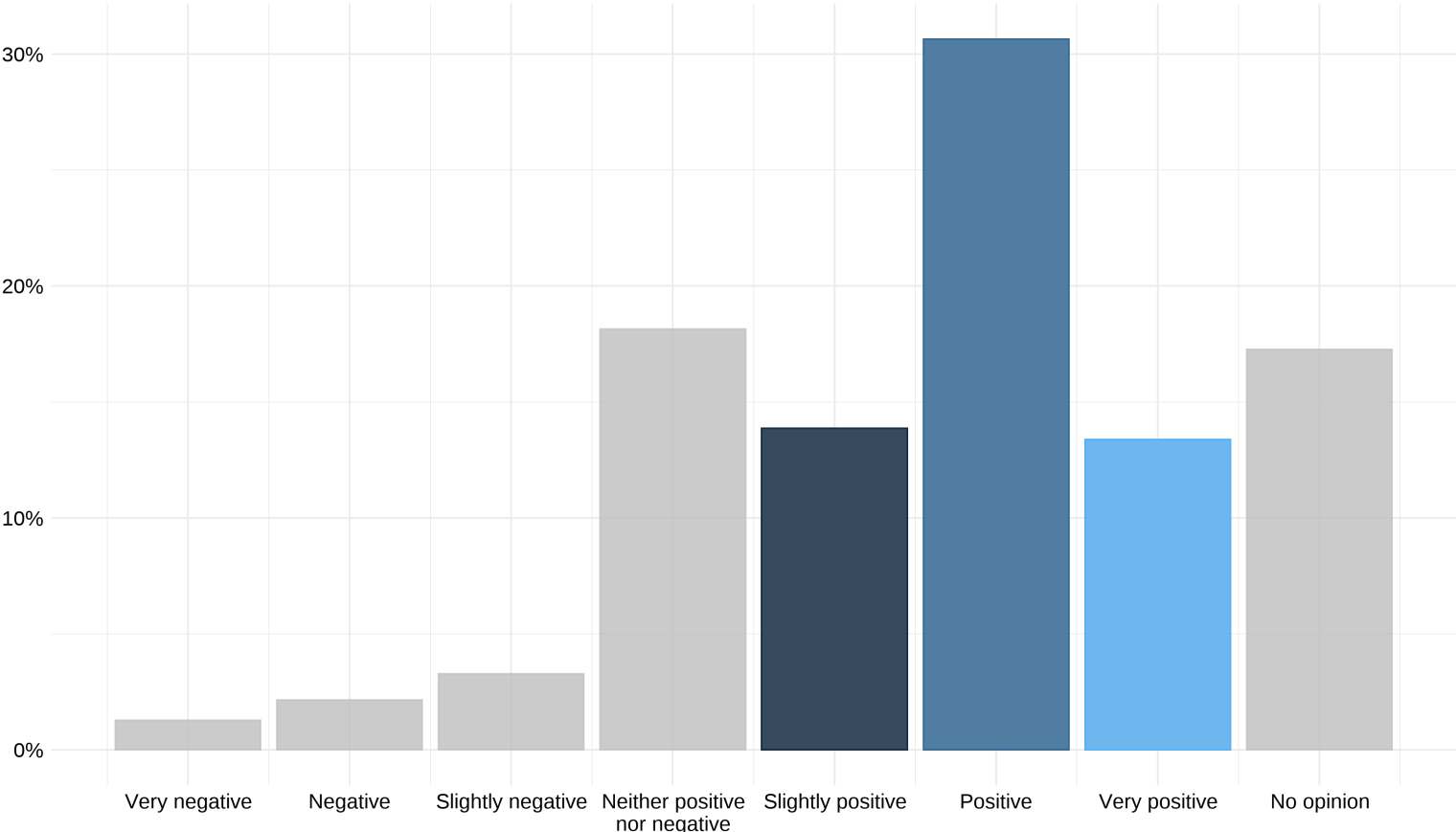
# Pilot-E project: Liquid hydrogen to decarbonize maritime transport in Norway

- BKK and co-operation partners are Equinor, Air Liquide, Norled, Wilhelmsen, Viking Cruises, NORCE, NCE Maritime Cleantech and NorSea Group.
- The project partners aim to develop, build, and operate a liquid hydrogen value chain supplying maritime applications in Norway.
- Work package on social acceptance (case studies and survey research)

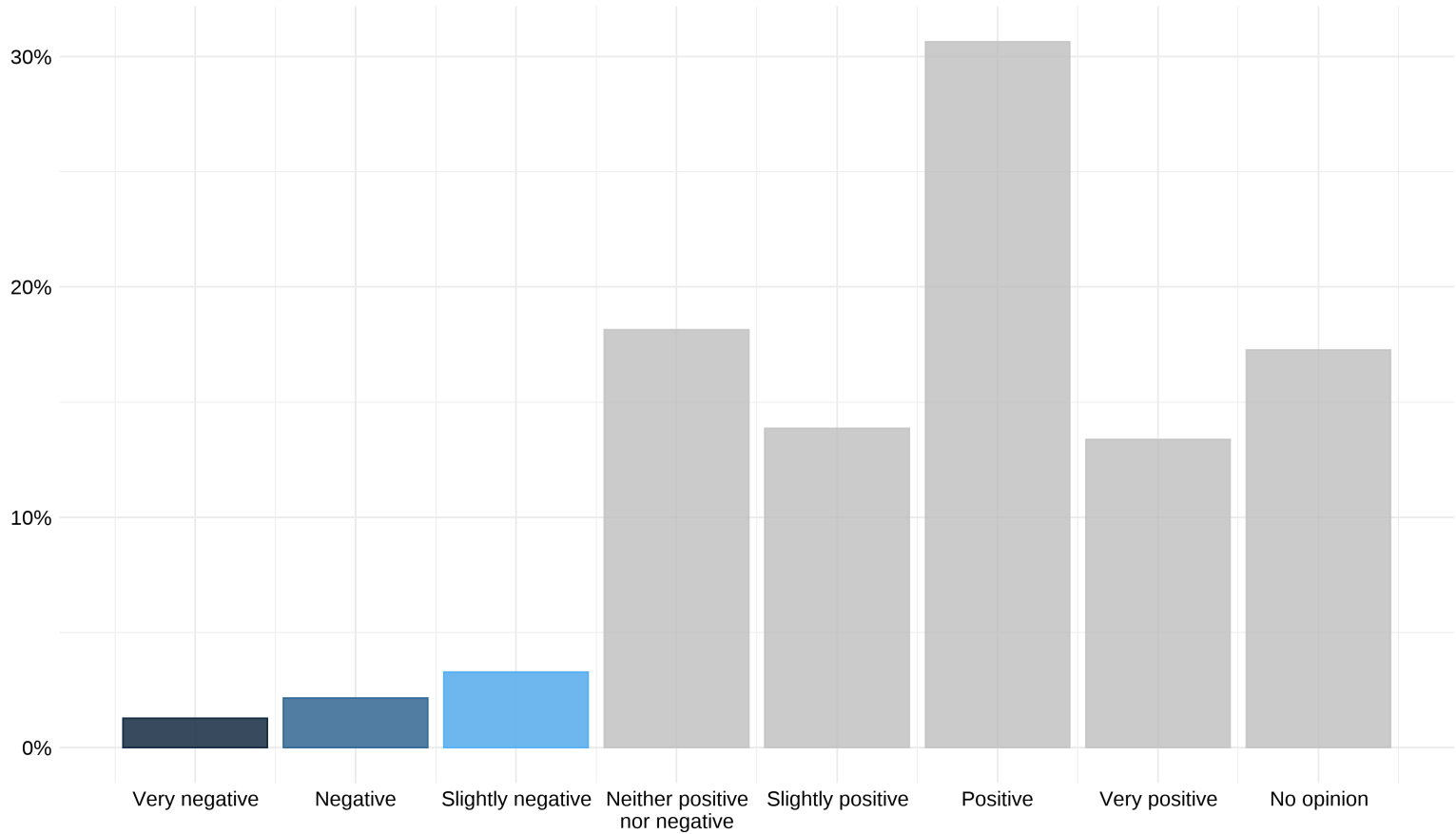
# Survey data on citizens hydrogen perceptions

- Data collected from the Norwegian Citizen Panel round 19
- A general question about citizens attitudes towards hydrogen (Kristin Guldbrandsen Frøysa and Trygve Skjold [UiB])
  - Do you have a positive/negative impression of hydrogen as a fuel for ferries/passenger ships?
  - 2503 respondents
- One survey experiment
  - Designed to study the effect of hydrogen production on citizens accept of hydrogen as an alternative fuel source
  - 1906 respondents

# In general, most citizens are positive to hydrogen as a fuel source for ferries/passenger ships

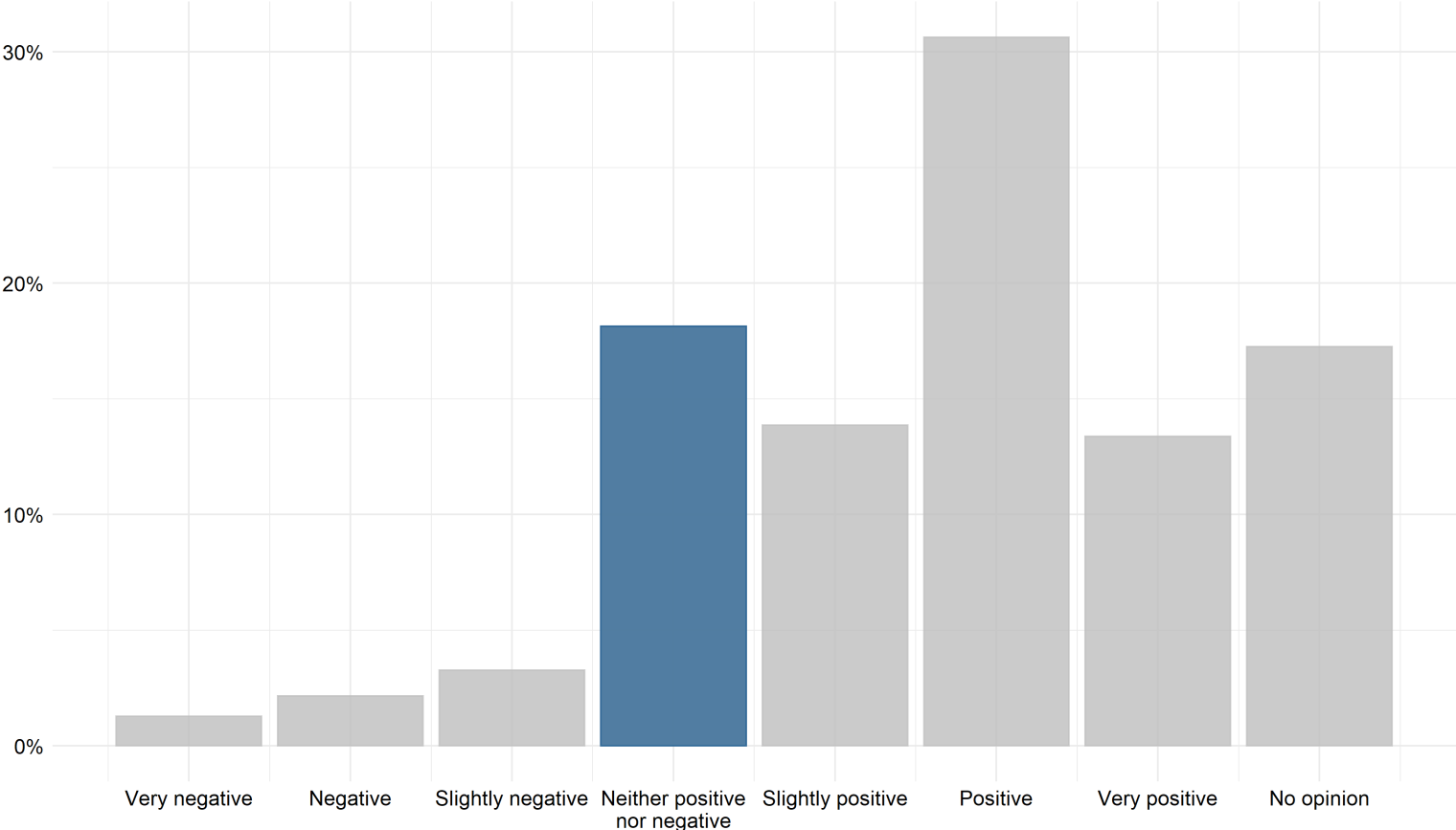


# Few citizens are negative

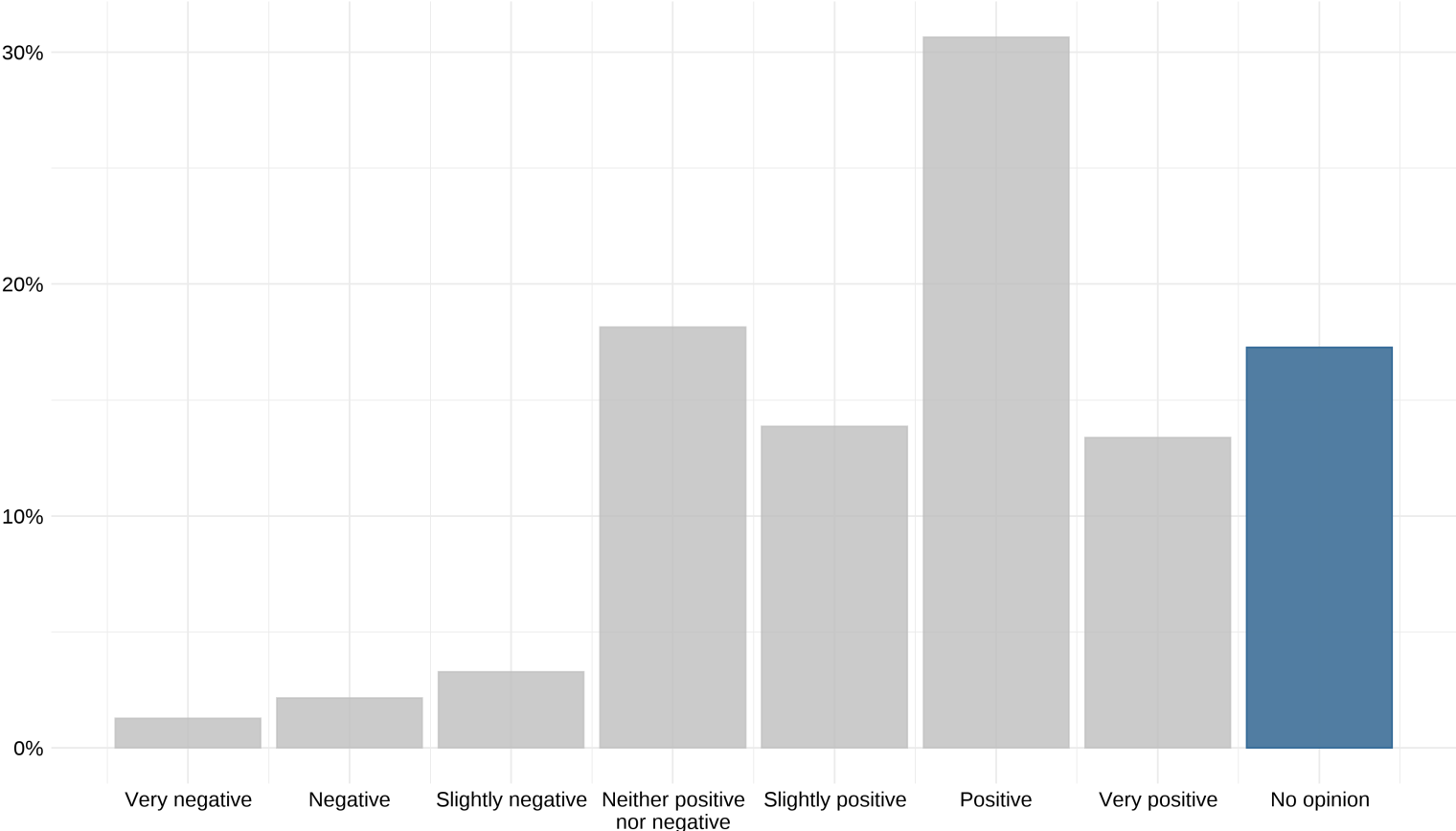




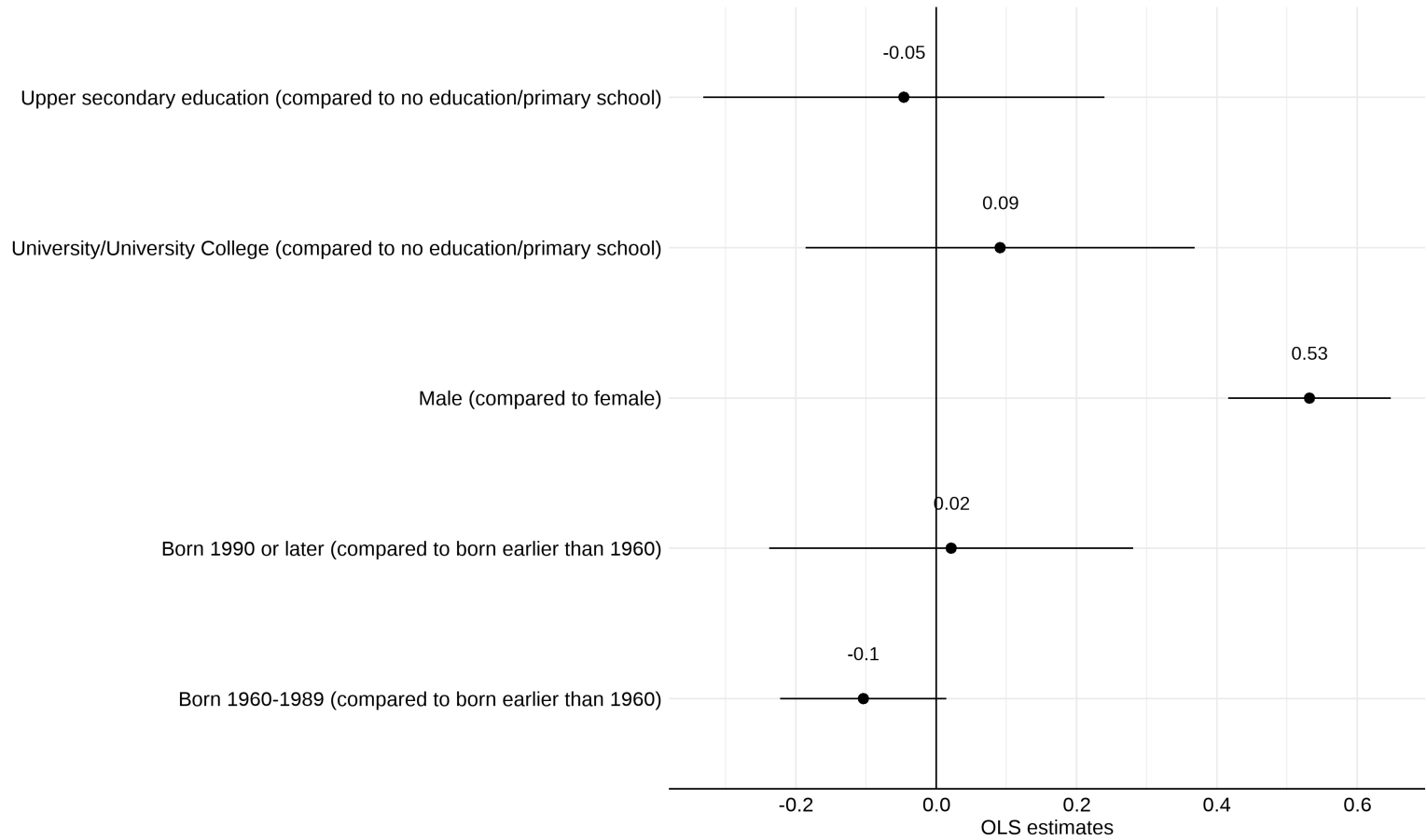
# And many are indifferent or have no opinion



# And many are indifferent or have no opinion



# Men are more positive than women



# Survey experiment

- All respondents are exposed to the following text

Hydrogen is an alternative fuel source for shipping in Norway. Among other things, hydrogen will be used to power Norway's first hydrogen ferry, which will operate for Norled on the Hjelmeland-connection from 2021. Hydrogen can be produced in different ways.

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- **1/3 of respondents randomly assigned to the gray-treatment**

So-called «gray» hydrogen uses coal, oil or natural gas, which means that the process of producing hydrogen generates large CO<sub>2</sub> emissions.

# Survey experiment

- All respondents are exposed to the following text

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- **1/3 of respondents are randomly assigned to the blue-treatment**

So-called «blue» hydrogen uses coal, oil or natural gas, but the CO<sub>2</sub> gas is separated from the hydrogen and returned to where it came from. In Norway, this means storing CO<sub>2</sub> under the seabed on the continental shelf.

# Survey experiment

- All respondents exposed to the following text

Hydrogen is an alternative fuel source for shipping in Norway. Among other things, hydrogen will be used to power Norway's first hydrogen ferry, which will operate for Norled on the Hjelmeland-connection from 2021. Hydrogen can be produced in different ways.

- **1/3 of respondents are randomly assigned to the green-treatment**

So-called «green» hydrogen is produced from electricity primarily generated from renewable energy sources, which generally does not involve any emissions of CO<sub>2</sub>.

# Survey experiment

Hydrogen is an alternative fuel source for shipping in Norway. Among other things, hydrogen will be used to power Norway's first hydrogen ferry, which will operate for Norled on the Hjelmeland-connection from 2021. Hydrogen can be produced in different ways.

gray | blue | green

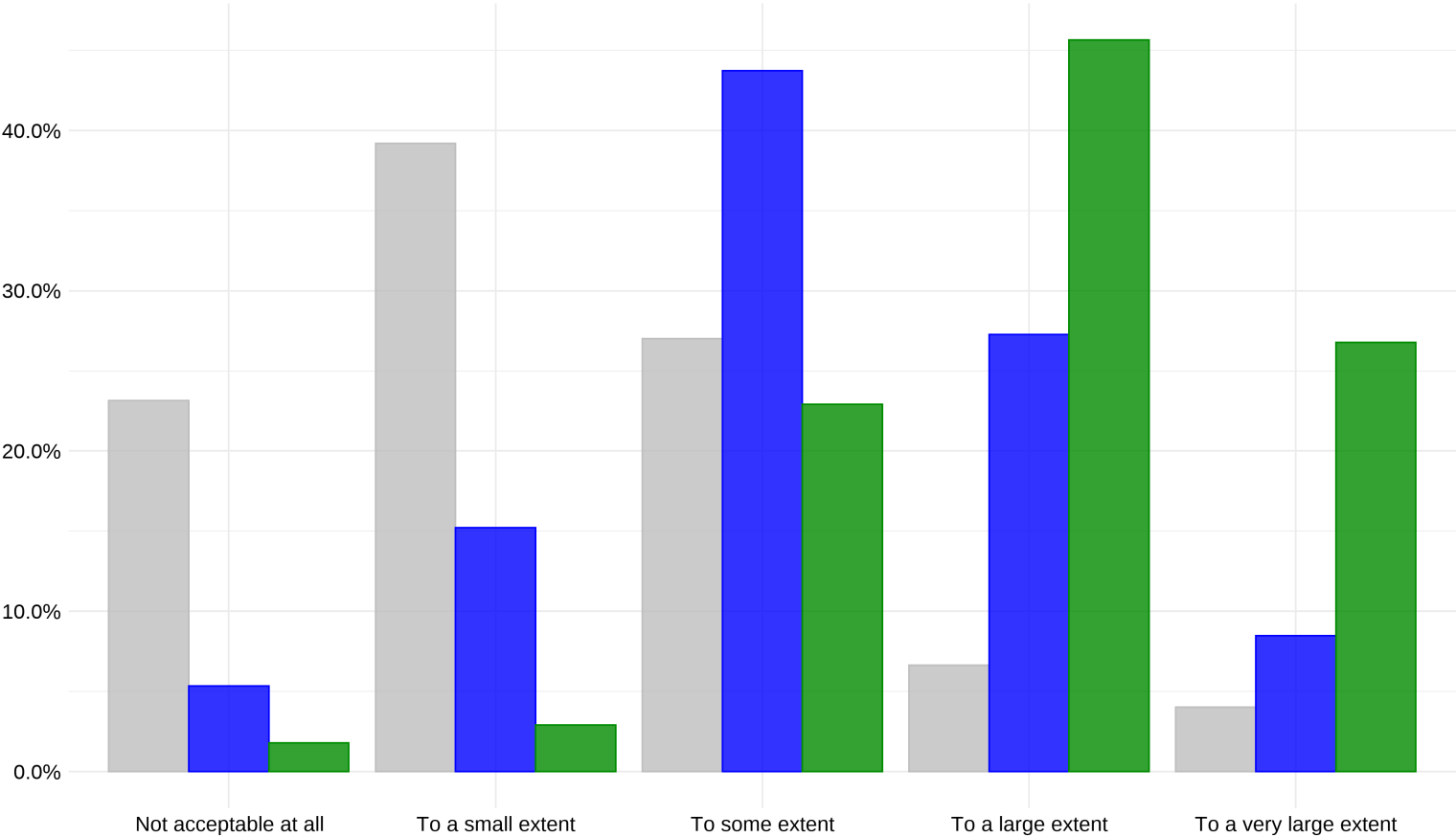
- All respondents answer the following question

To what extent do you think it is acceptable that shipping traffic in Norway is powered by hydrogen produced in this way?

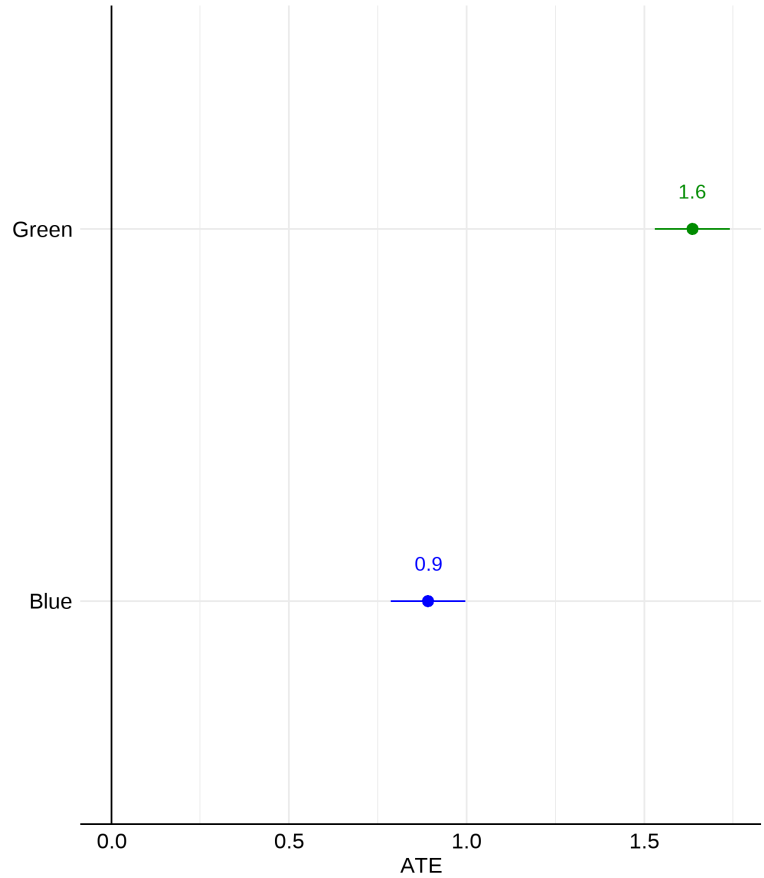
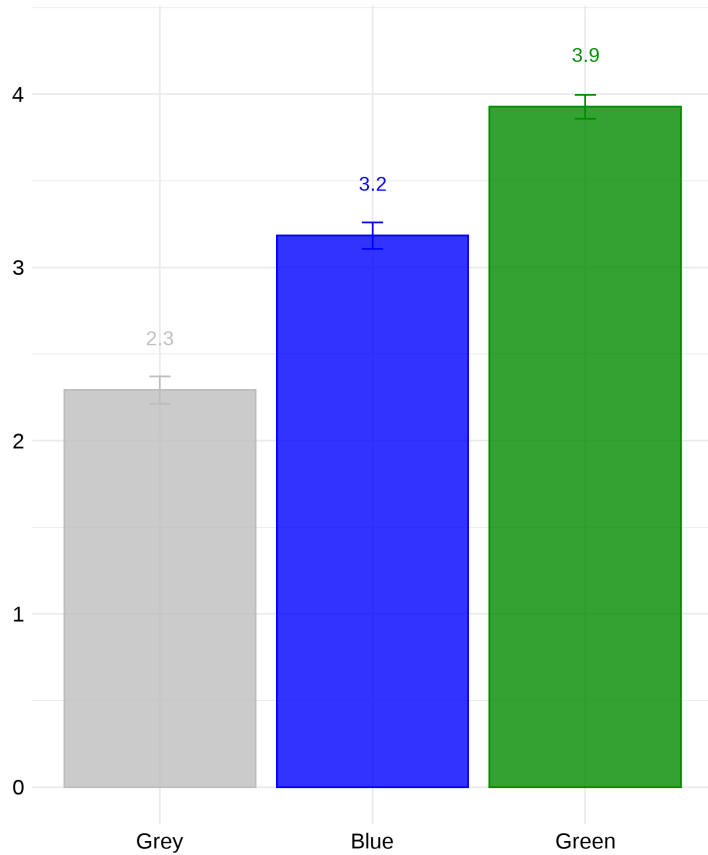
- 1 Not acceptable at all
- 2 To a small extent
- 3 To some extent
- 4 To a large extent
- 5 To a very large extent



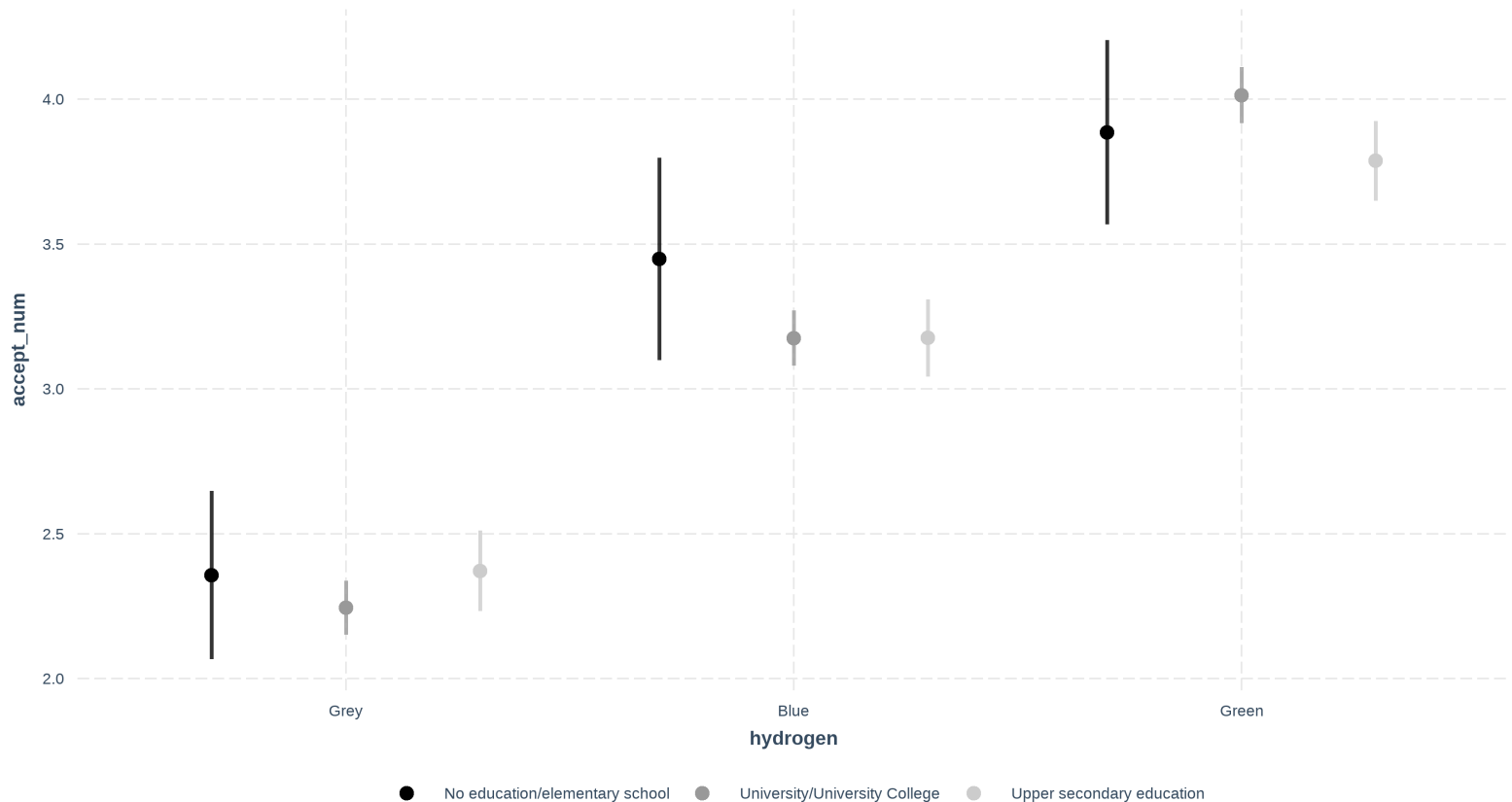
# Acceptability perceptions among citizens exposed to gray, blue or green hydrogen



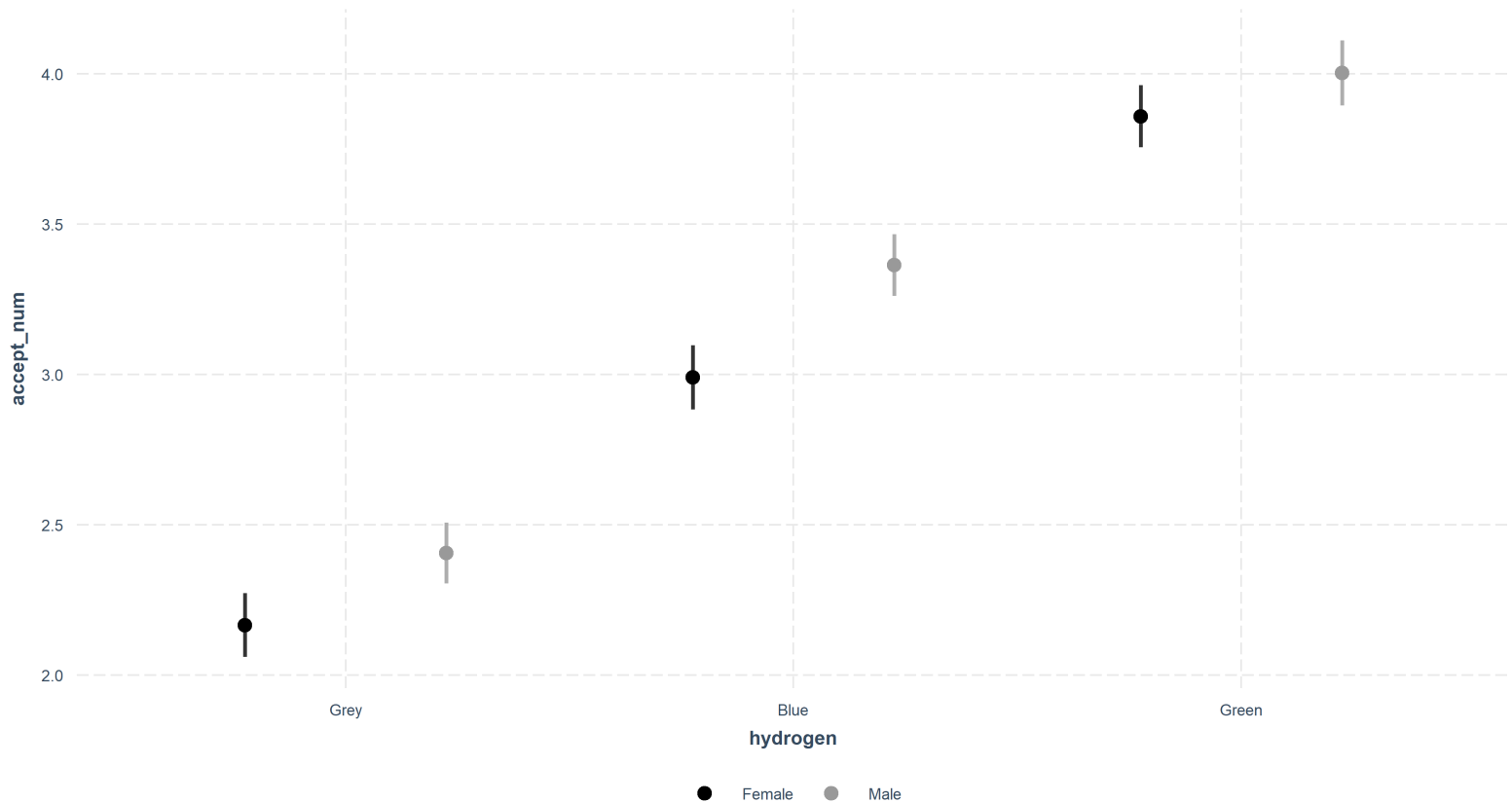
# Citizens prefer **green** over **blue** and **blue** over **gray**



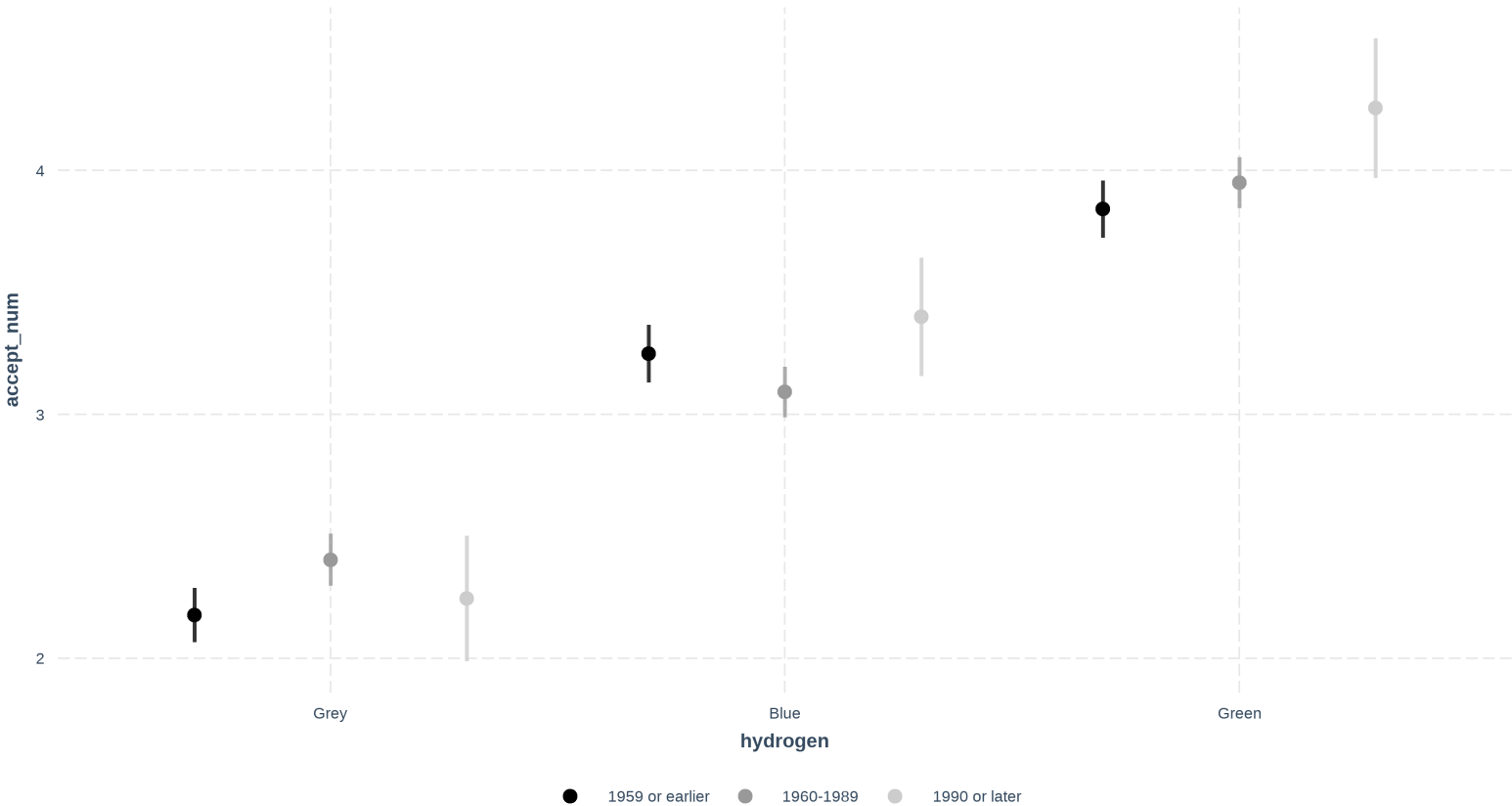
# Citizens accept for green, blue and gray are fairly similar across different levels of education



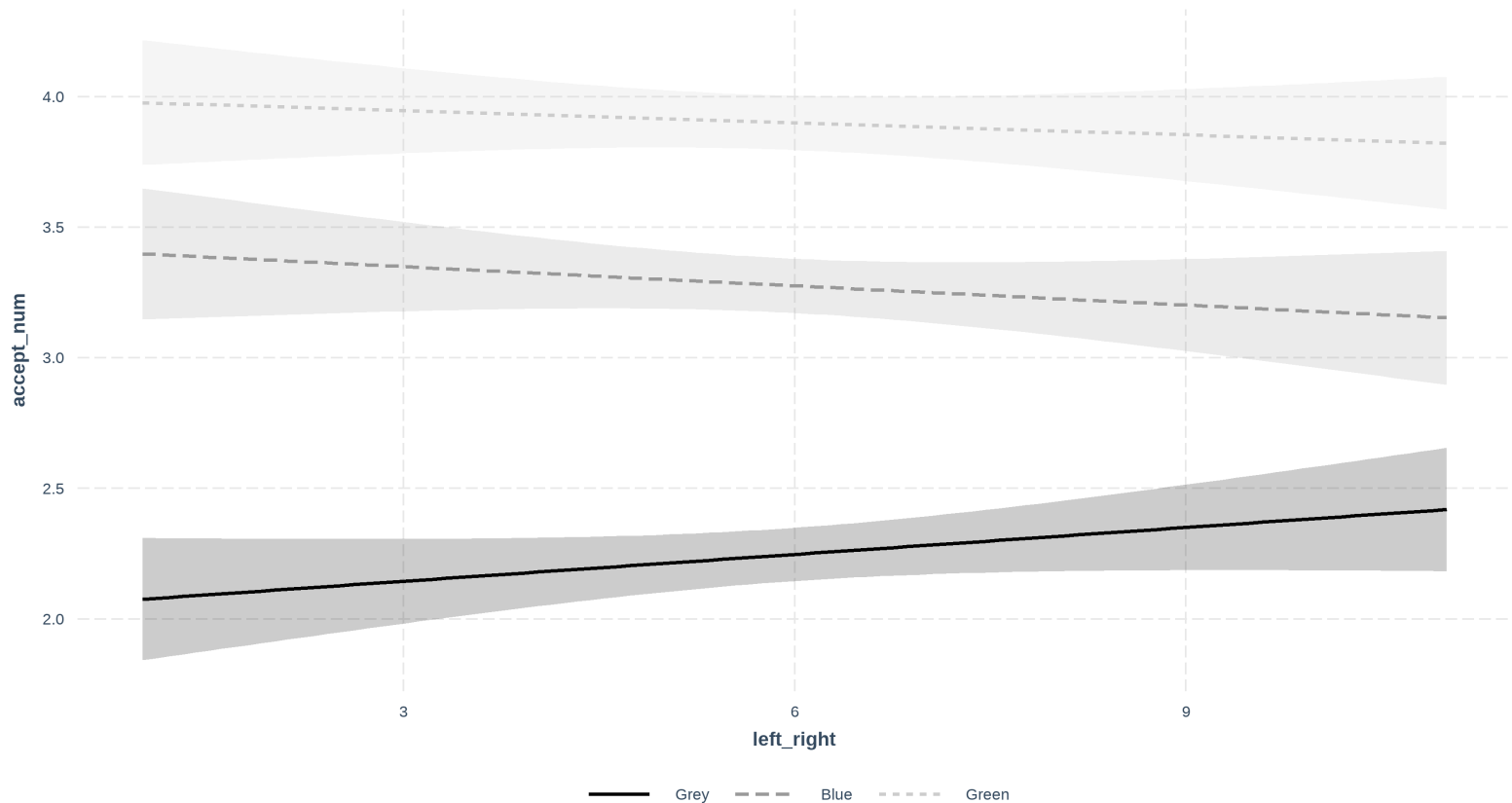
# Women show lower accept for blue and gray than men



# The youngest citizens have higher accept for green than the oldest citizens



# There is some (but not statistically significant) movement across individuals' political preferences



# Conclusion

- People are positive towards hydrogen
  - many have no opinion
  - men are more positive than women
- People support green and blue, but not grey
- People prefer green over blue and blue over grey
- Why green over blue?
  - People appear to perceive hydrogen as green, so any indications of the opposite leads to less support
  - Not a complete move away from fossil fuels
  - Perceptions about carbon capture and storage
  - Question wording: Is it not perceived as emission free?
- Women are less supportive of gray and blue than men
- Younger are more supportive of green than the oldest citizens

# References

Achterberg, Peter, Dick Houtman, Samira van Bohemen, and Katerina Manevska. 2010. "Unknowing but Supportive? Predispositions, Knowledge, and Support for Hydrogen Technology in the Netherlands." *International Journal of Hydrogen Energy* 35 (12): 6075–83. <https://doi.org/10.1016/j.ijhydene.2010.03.091>.

Peterson, Tarla Rai, Jennie C. Stephens, and Elizabeth J. Wilson. 2015. "Public Perception of and Engagement with Emerging Low-Carbon Energy Technologies: A Literature Review." *MRS Energy & Sustainability* 2. <https://doi.org/10.1557/mre.2015.12>.

Ricci, Miriam, Paul Bellaby, and Rob Flynn. 2008. "What Do We Know about Public Perceptions and Acceptance of Hydrogen? A Critical Review and New Case Study Evidence." *International Journal of Hydrogen Energy* 33 (21): 5868–80. <https://doi.org/10.1016/j.ijhydene.2008.07.106>.