



Energy research Centre of the Netherlands



Filling up your car in the Netherlands – what does it mean for H₂ infrastructure?

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OVERVIEW

- The THRIVE project and objectives
- Overview of our study
- Results
- Main messages from the survey
- Application in THRIVE allocation model



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The THRIVE project

Towards a **H**ydrogen **R**efuelling Infrastructure for **V**ehicles

- A Dutch research project (2007 – 2010)
- Project partners: ECN, Linde, Shell, TNO
- Sponsor: Dutch Ministry of Economic Affairs
- Focus:
 - Hydrogen as transport fuel
 - Passenger cars
 - The Netherlands
 - Commercialisation phase

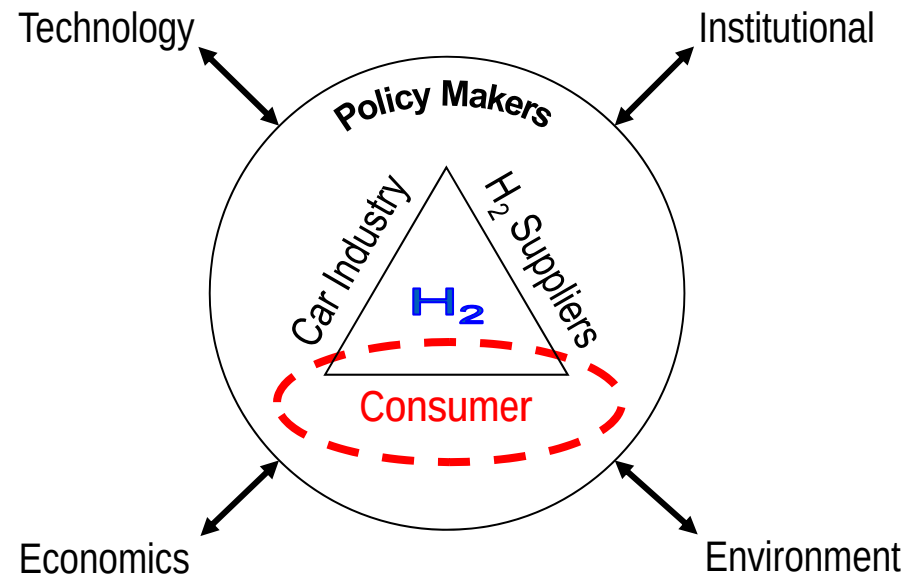


Background

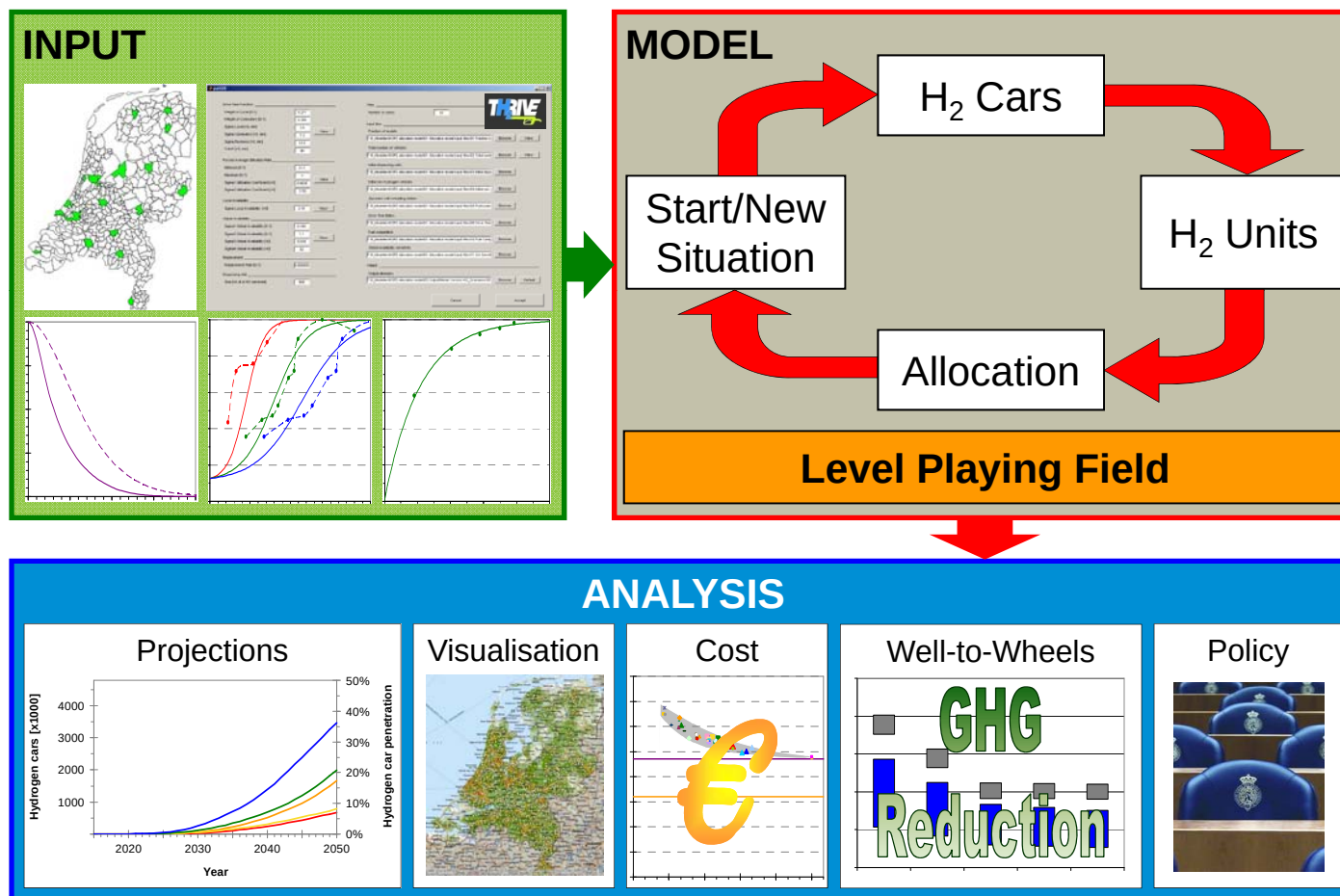
- Need for sustainable mobility
- Lack of integrated perspective
- Demand-pull besides technology-push
- Real-world conditions

Project objective

- Identification of plausible rollout scenarios
 - Growth of a H₂ car fleet
 - Development of a H₂ refuelling infrastructure
- Considerations



Project approach





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Hydrogen refueling from a consumer perspective

- Refueling behaviour takes into account the spatial and time dimension of consumer decision making
 - Where do people refuel most? Why and when?
- Perceived fuel availability plays a large role in the decision to buy a car
 - What initial station coverage is required given the varying values and norms for refueling in different countries?
- The roll-out of a hydrogen infrastructure should take into account current user behaviour
 - Refueling process as close as possible to conventional refueling
 - Integrated into existing conventional stations



Previous studies

- Most research into behavioral patterns concerning refueling was carried out in the California (Sperling, Kitamura; UC Davis)
 - People tend to refuel in areas that are known to them (home, work)
 - No dedicated trips to refuel
 - Drivers interrupt their journey in the beginning or near the end
 - Willingness to make a detour if additional time is offset by lower fuel price
 - Initial hydrogen station network along high-volume commuting routes
- Spatially well-planned refueling infrastructure with high predictability of stations can compensate for lower overall availability



Our research

- Aims to provide insights on current refueling behaviour of Dutch car drivers
- How does it differ from previous research results from the US?
 - Are there significant behavioral deviations concerning refueling in Europe (The Netherlands)?
 - How does the specific spatial situation influence the outcomes?
 - High population density
 - Biggest towns concentrated in a small geographical area (Amsterdam, Utrecht, Den Haag, Rotterdam)
- What are the implications for the THRIVE model?



Research methodology

- Internet-based survey among over 2900 Dutch households
 - Sample based on TNS-Nipo (market research company) database
 - At least one car had to be present in the household
- 12 questions regarding refueling habits
 - 1. Current refueling behaviour (when, where, why, detour?)
 - 2. Willingness to switch to an alternative fuel
 - Pre-conditions for fuel switching
 - Required station coverage with alternative fuel to switch
- Data segmented by demographics: gender, age, education, location

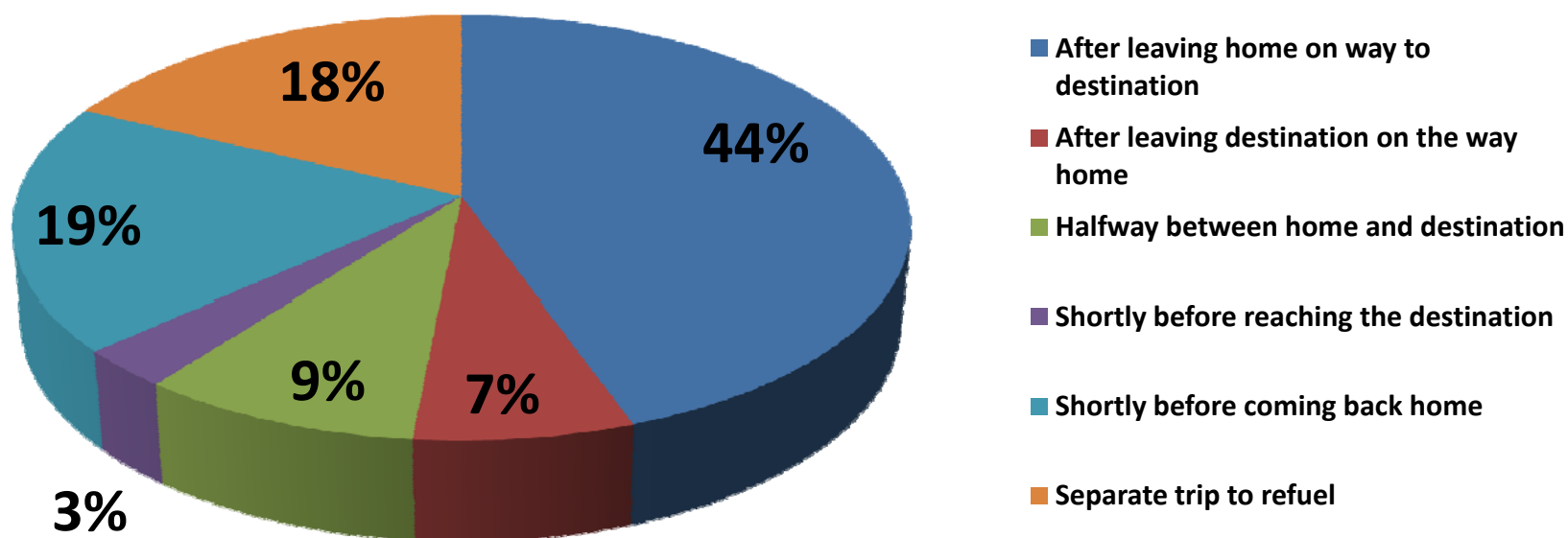


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1. Refueling behaviour

When do you refuel?

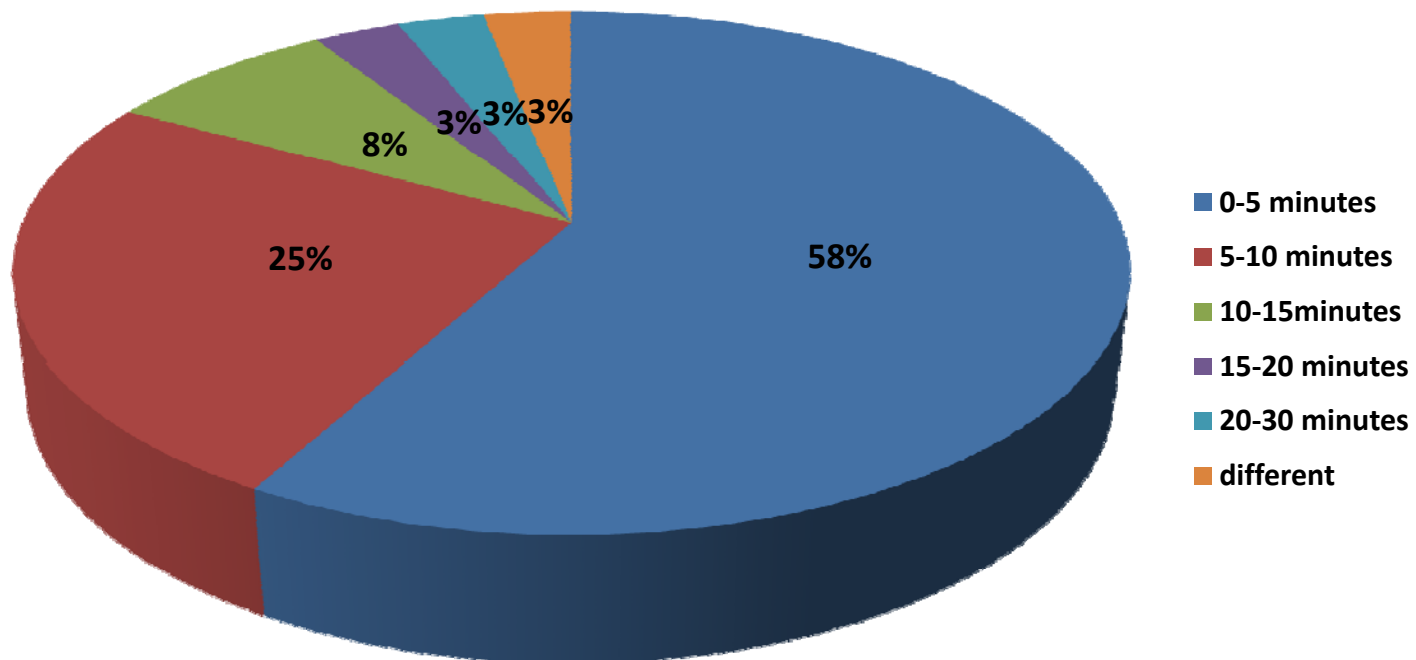


Risk aversion behaviour – drivers tend to refuel where they have a good 'mental map' of the area

Source: TNS NIPO survey of 2900 households

1. Refueling behaviour

Travel time between departure and refueling station

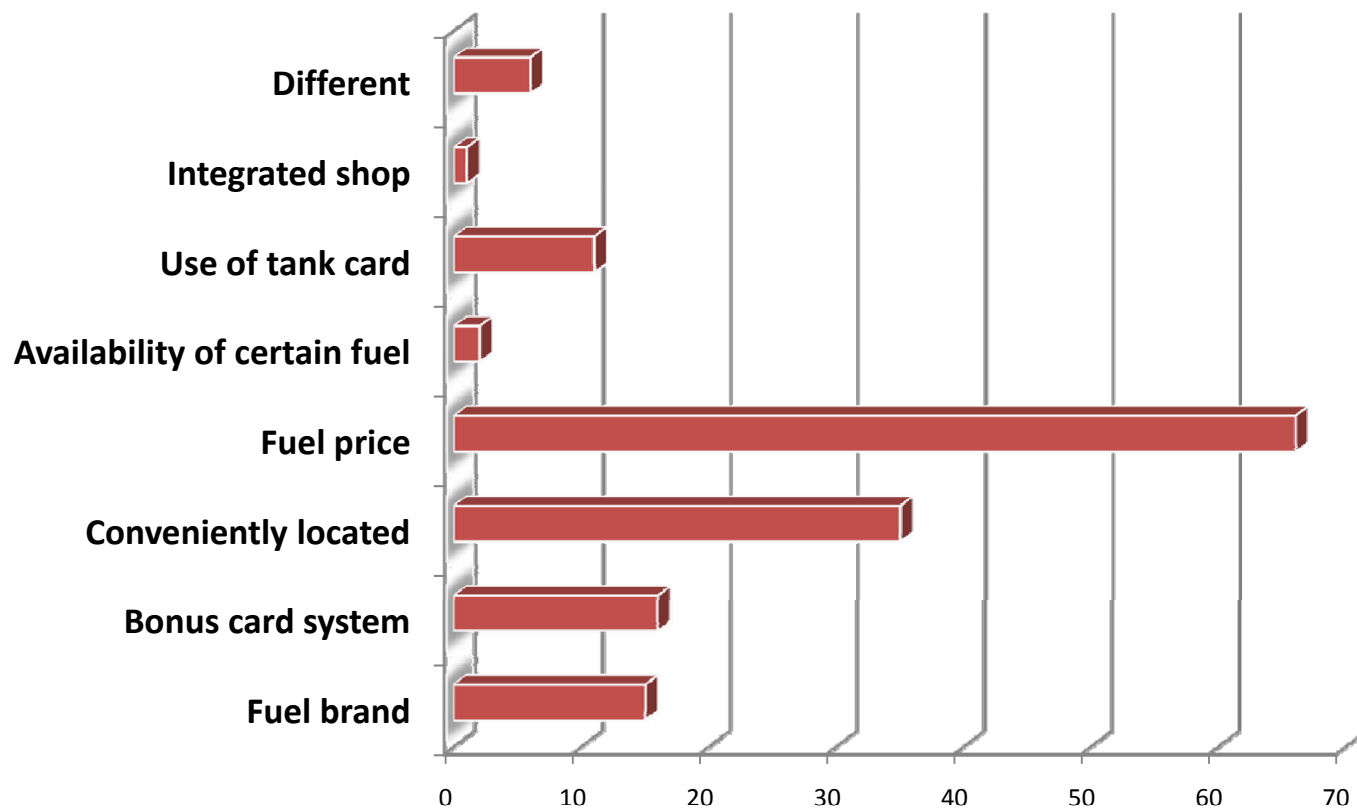


First 10 minutes after departure count ~ 83%

Source: TNS NIPO survey of 2900 households

1. Refueling behaviour

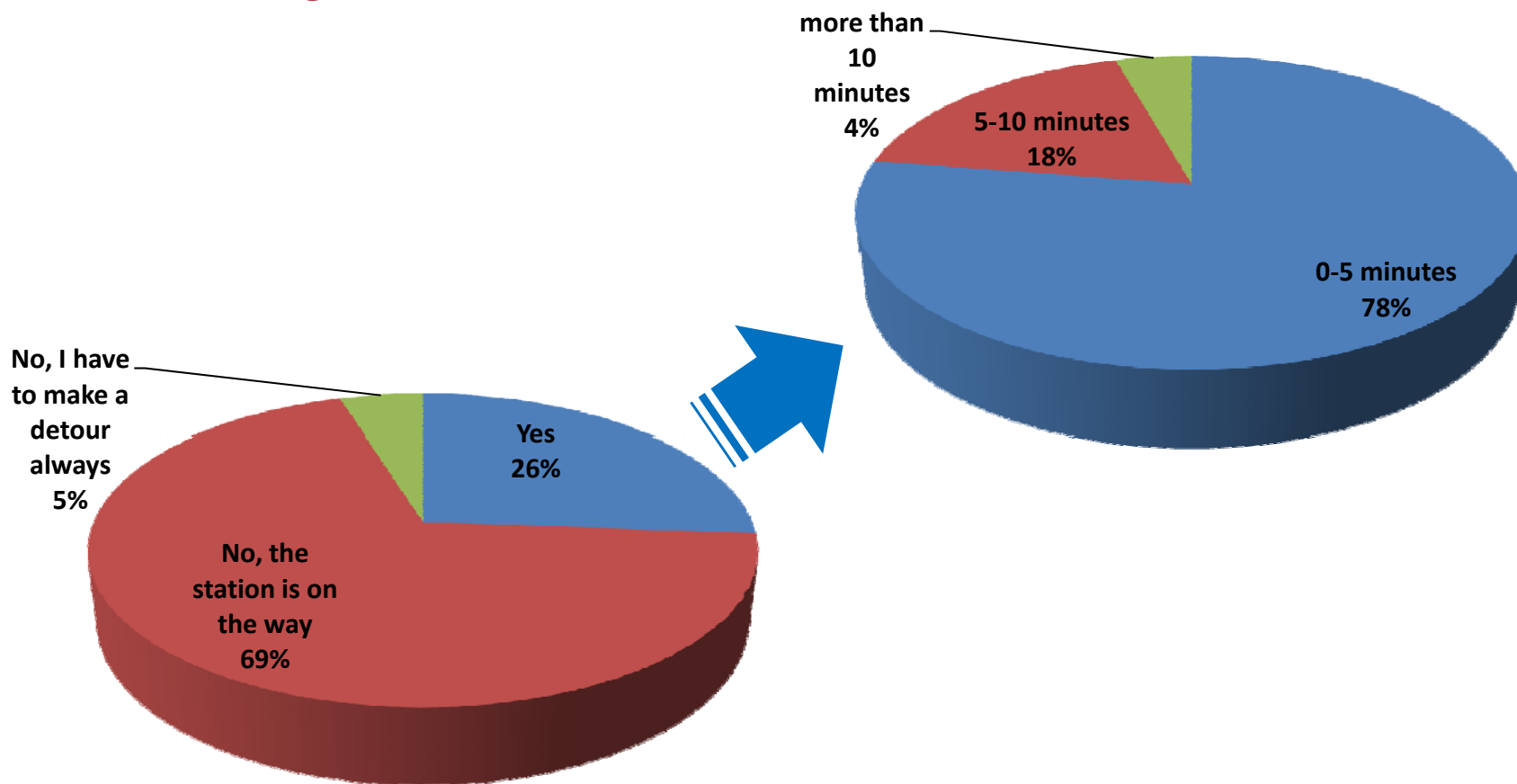
Choice of refueling station



More than 1 answer possible!

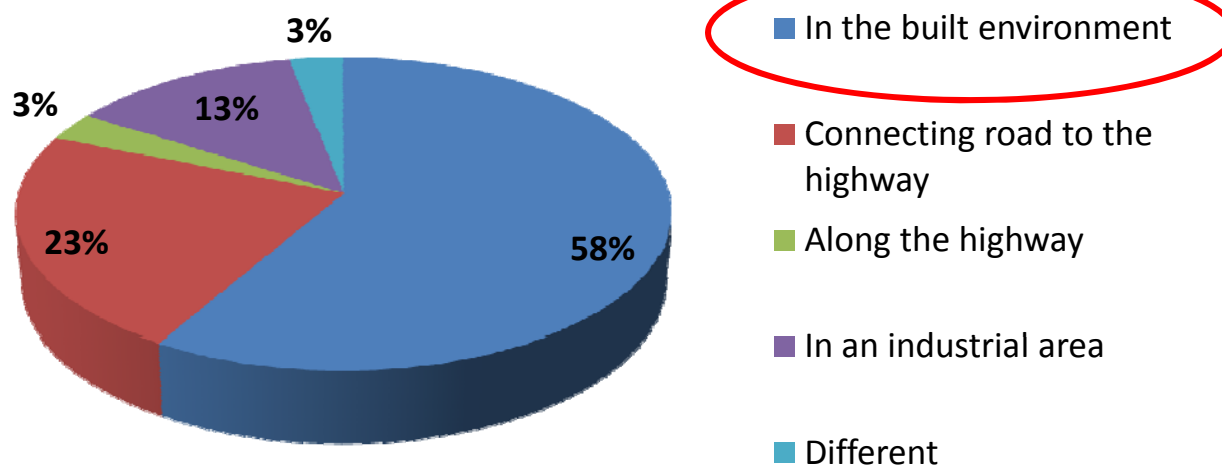
Source: TNS NIPO survey of 2900 households

1. Refueling behaviour– Do you take a detour? How long?



Source: TNS NIPO survey of 2900 households

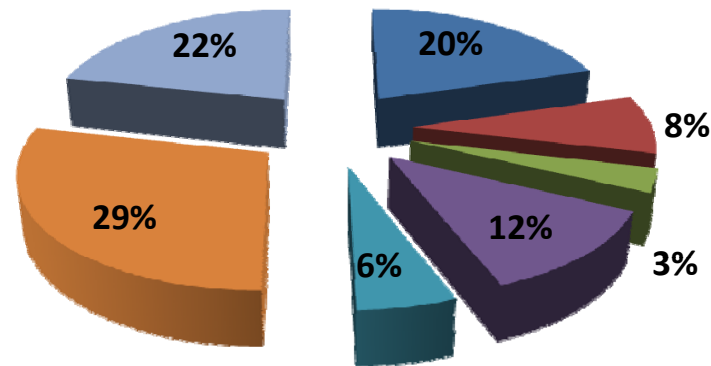
1. Refueling behaviour - location



Link to refueling moment!

Source: TNS NIPO survey of 2900 households

2. Willingness to switch to an alternative fuel

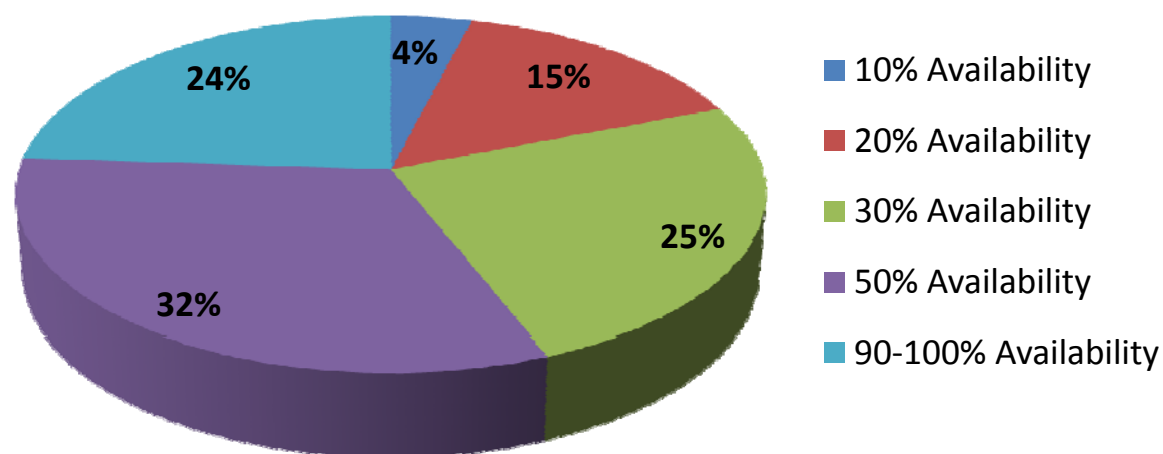


- Available at my usual filling station
- Available on at least one of the stations along my daily route
- Available on at least two of three stations along my daily route
- Available at a filling station in my neighbourhood, ready for 5min de
- Available at a gas station in my neighbourhood, ready for 10min de
- **Has to be available 'sufficiently' to cross the Netherlands**
- Has to be available also abroad for vacation trips

**This group was
presented a
follow-up question**

Source: TNS NIPO survey of 2900 households

2. Fuel availability – station coverage



With 1 out of three H2 stations you reach 44% of all drivers

With 1 out of two H2 stations you reach 76% of all drivers

Source: TNS NIPO survey of 2900 households



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Main messages and conclusions

- Fuel price and location are the key issues in the consumer refueling decision making
- Hydrogen refueling infrastructure should be available in the built environment to serve user needs
 - Increases perceived availability of hydrogen
- Drivers prefer to visit a station along their habitual route
 - Low willingness to make an extra detour
- Stations along the highway are required to allow to long-distance travel
- Consumers require availability abroad: Need for synchronized EU rollout, no island solutions

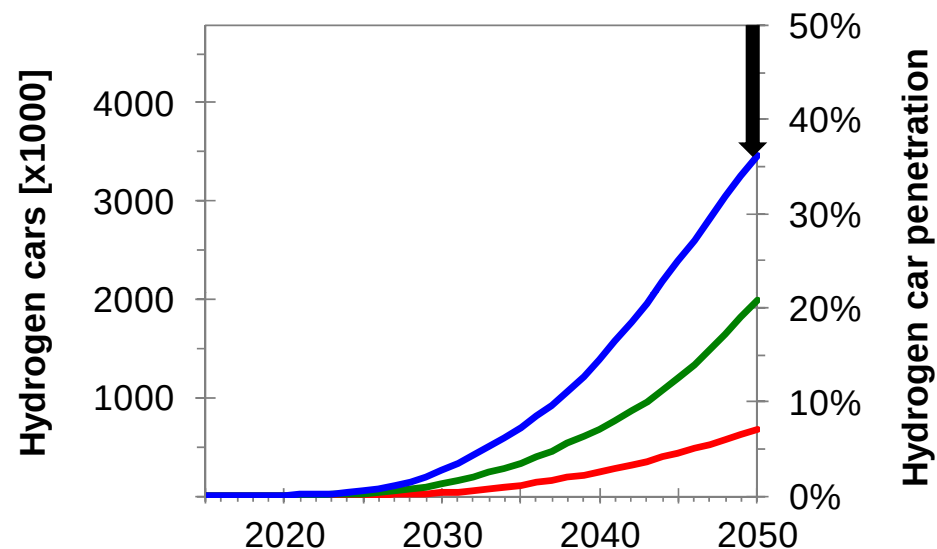


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High Scenario



Scenario	Low	Medium	High
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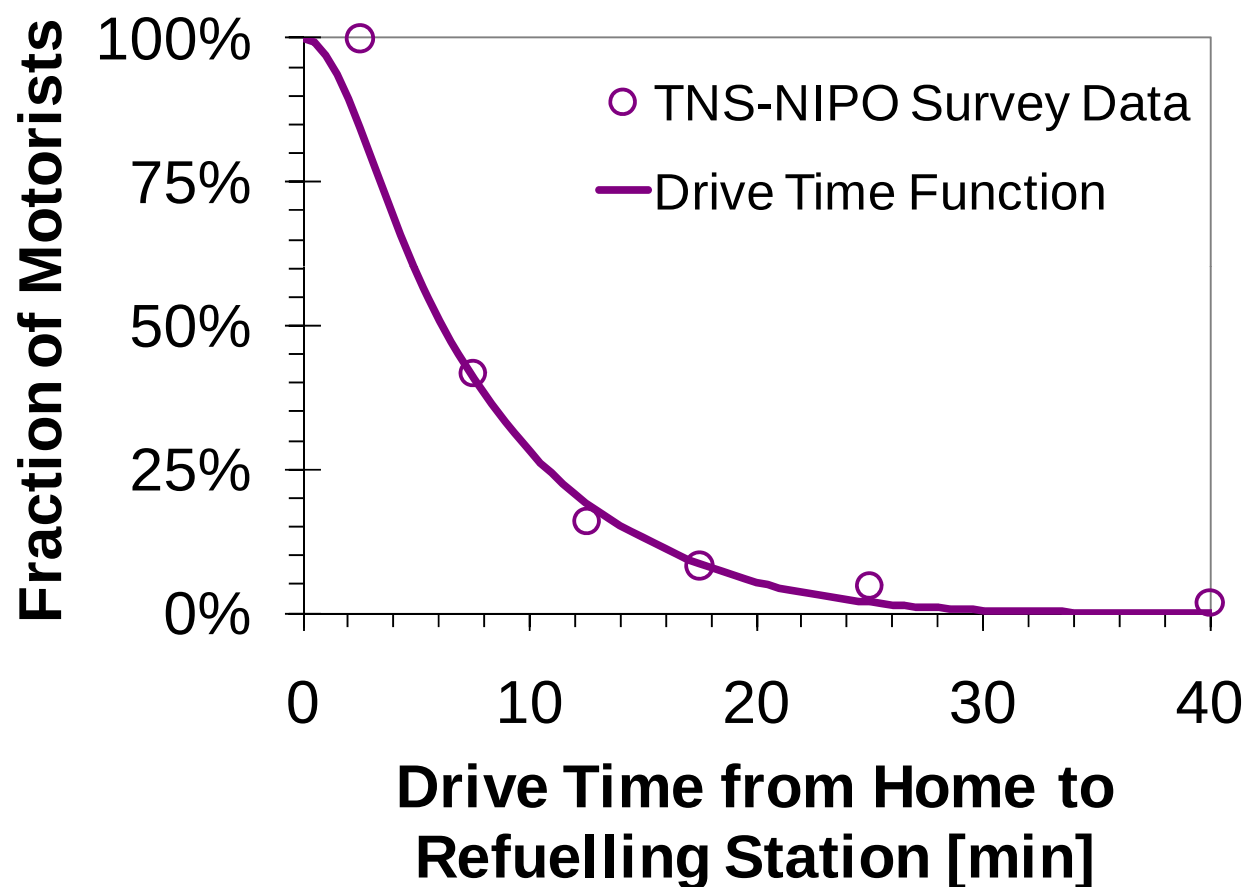
■ → ■	Increasing number of H ₂ refuelling units
■ → ■	Increasing H ₂ car penetration



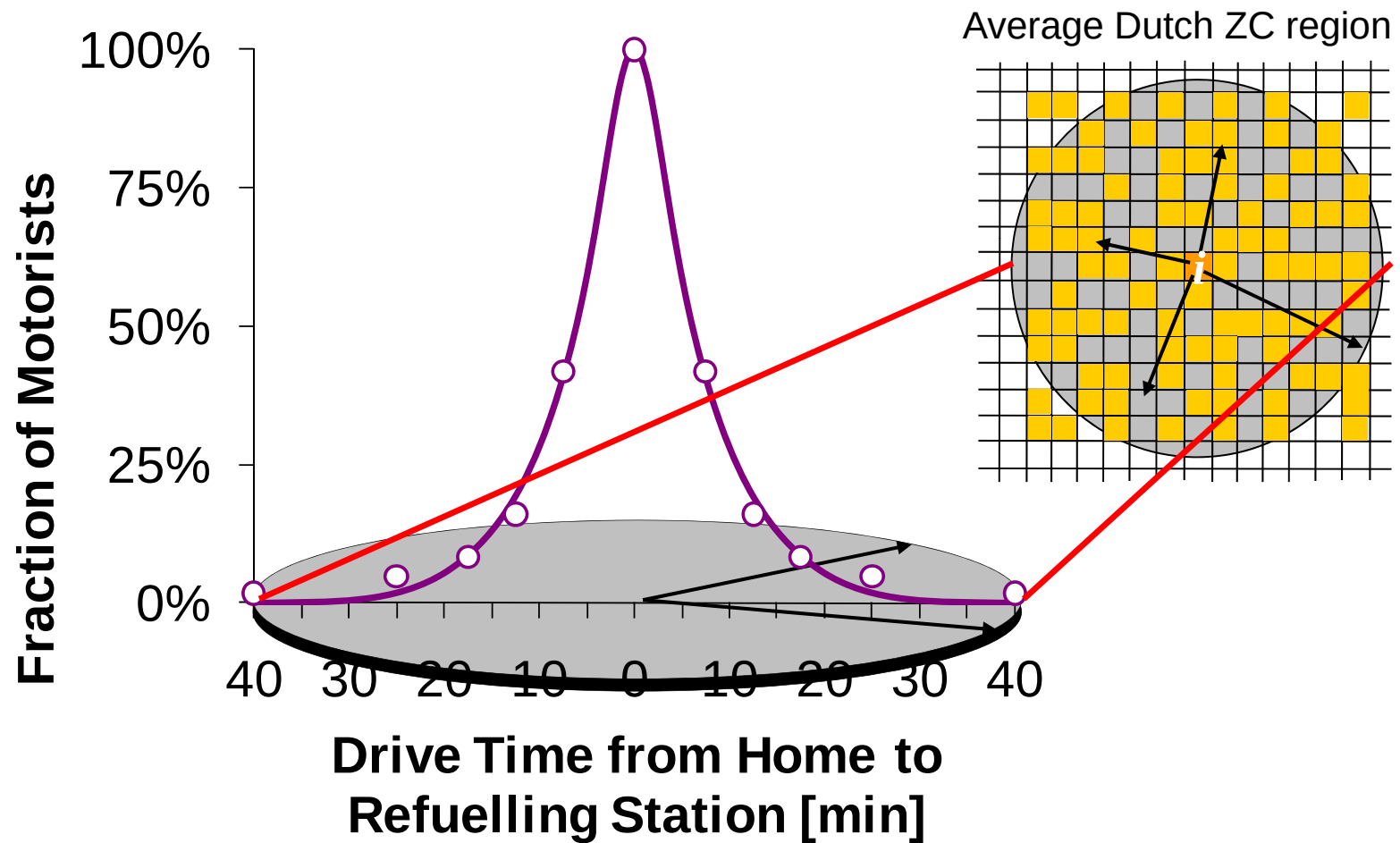
Survey results and Drive Time Function

- Local fuel availability
 - Cumulative share of motorists driving $<x$ minutes from their home to the refueling station, where they refuel most
 - A zip code with a refueling station has a certain “catchment” area; it attracts customers from within, whereas customers that live closer are more attracted
 - By knowing “real” drive times between zip codes, the local availability of hydrogen (refueling stations) as perceived by customers (being reflected in the drive time function) is evaluated
- Global fuel availability
 - Which stations do people refer to when they think about “x out of 10”?
 - Thus they only perceive around 300 refueling stations in 200 zip codes (instead of all 4300 stations in 2200 zip codes)

Drive Time Function and local availability (2)



Drive Time Function and local availability (3)





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Agentschap NL
Ministerie van Economische Zaken



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