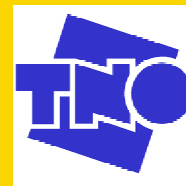




Energy research Centre of the Netherlands



Impact of industry strategies and consumer attitude on growth of the H₂ vehicle fleet and refuelling infrastructure

World Hydrogen Energy Conference 2010, Essen, 18 May 2010



Presented by Paul Lebutsch

www.ecn.nl

Overview

- Introduction THRIVE project
- THRIVE ALLOCATE – rollout simulation model
- Results
- Sensitivities
- Conclusions

Overview

- **Introduction THRIVE project**
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Introduction THRIVE project

Towards a **H**ydrogen **R**efuelling Infrastructure for **VE**hicles

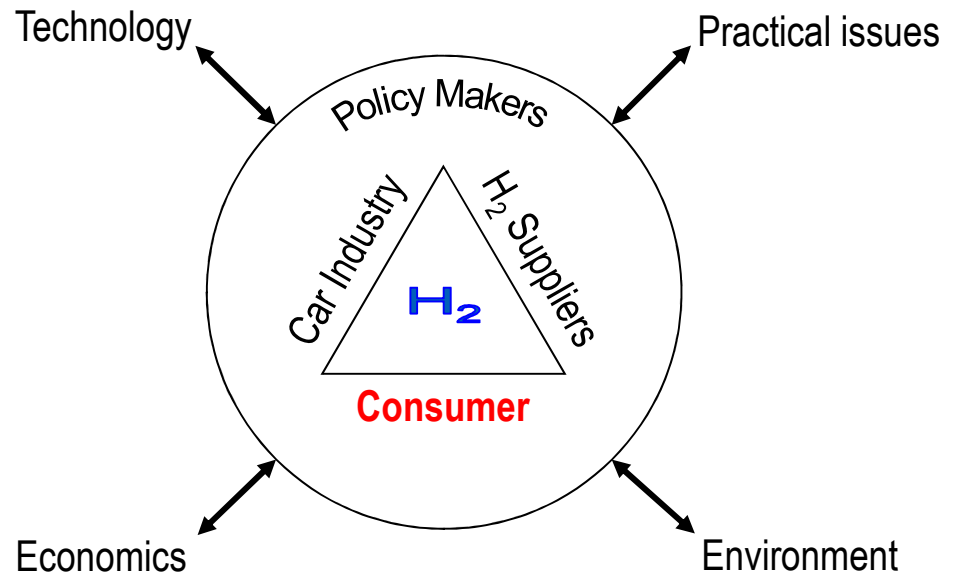
- A Dutch research project (2007 – 2010)
- Project partners: ECN, Linde, Shell, TNO
- Sponsor: Dutch Ministry of Economic Affairs
- Focus:
 - Hydrogen as transport fuel
 - Passenger cars
 - The Netherlands
 - Commercialisation phase

Background

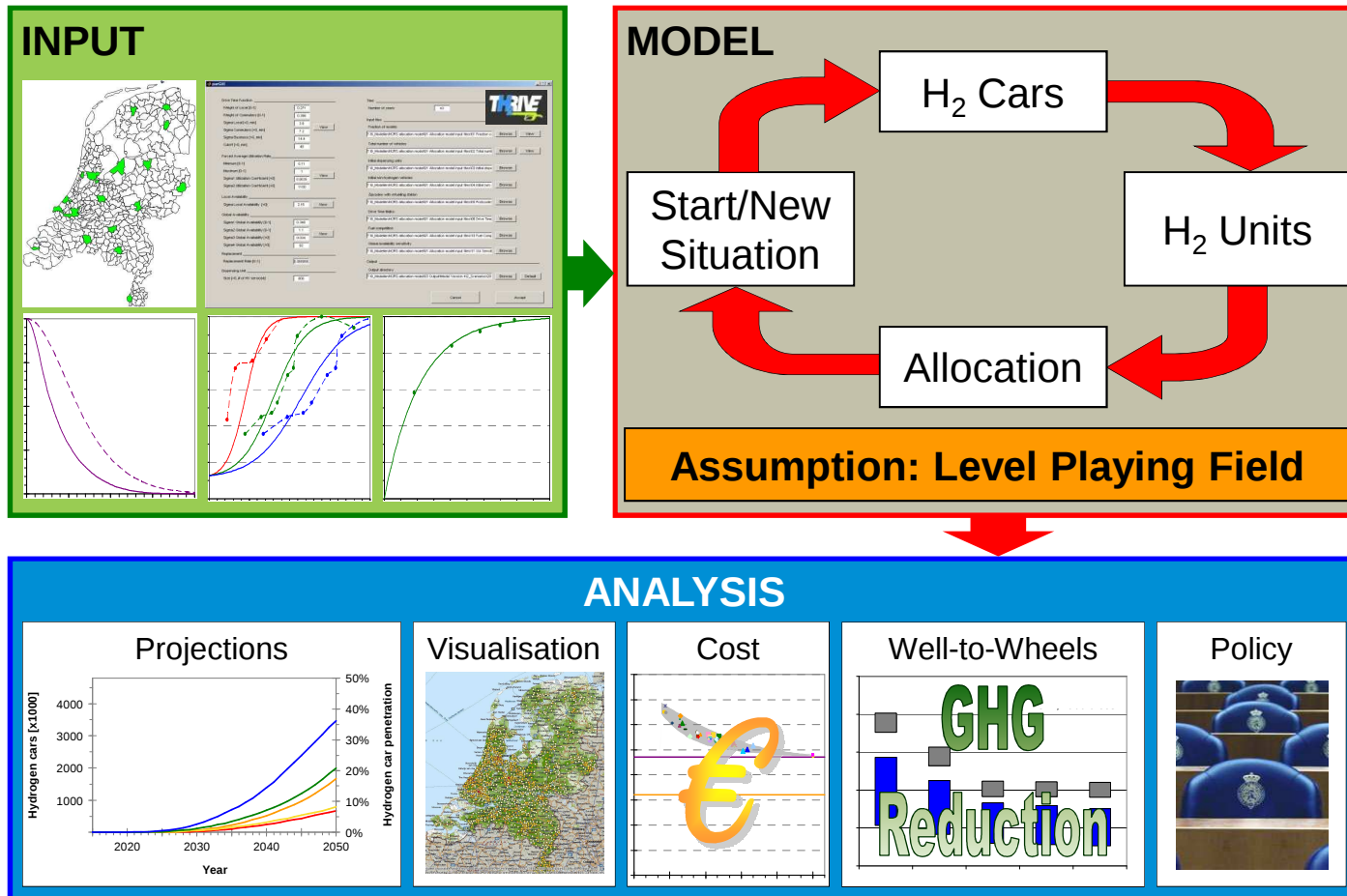
- Need for sustainable mobility
- Lack of integrated perspective
- Demand-pull besides technology-push
- Real-world conditions

Project objective

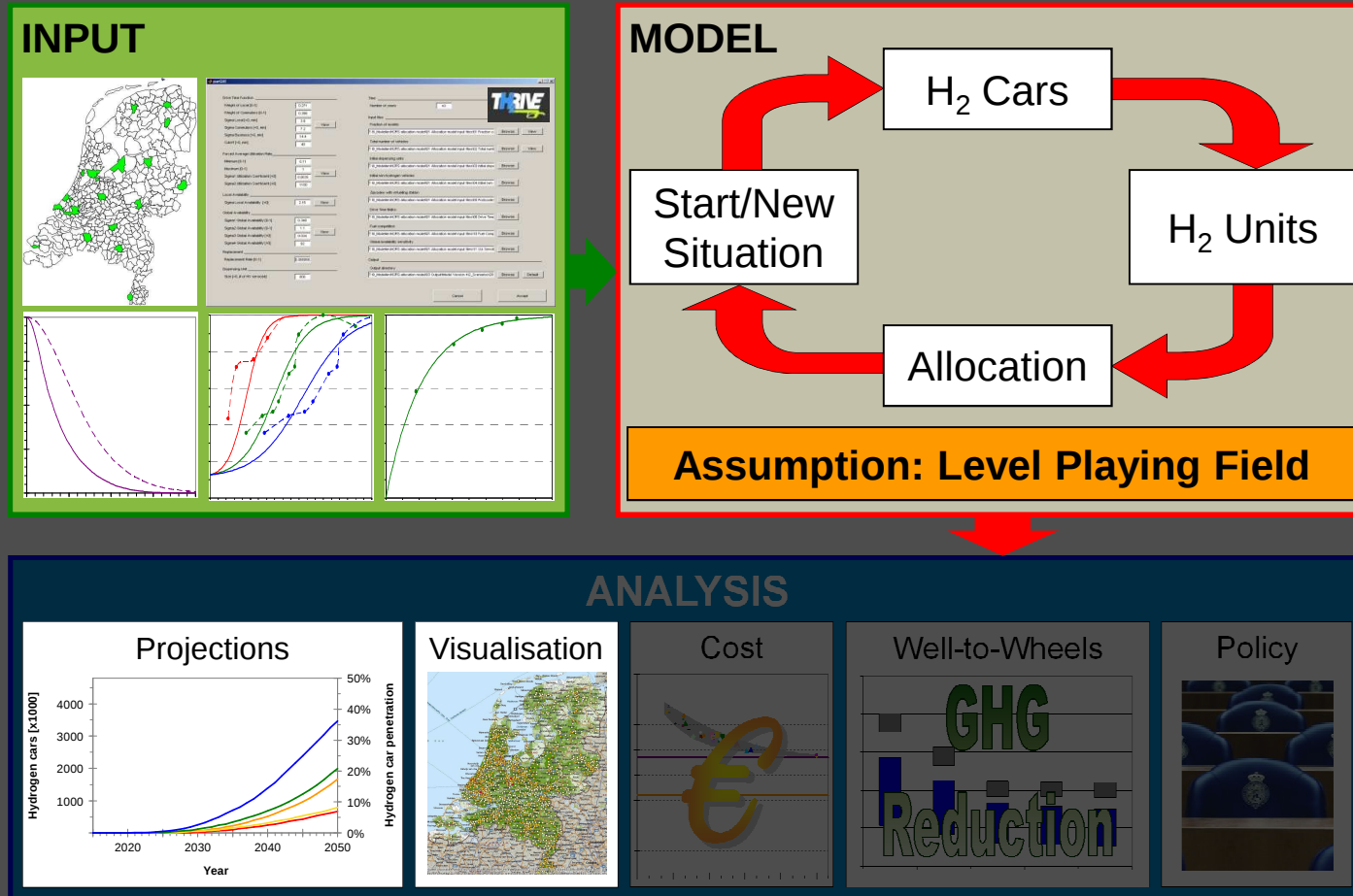
- Identification of plausible rollout scenarios:
 - Growth of a H₂ car fleet
 - Development of a H₂ refuelling infrastructure
- Considerations:



Project approach



Project approach



Overview

- Introduction THRIVE project
- **THRIVE Allocation Model**
- Results
- Sensitivities
- Conclusions

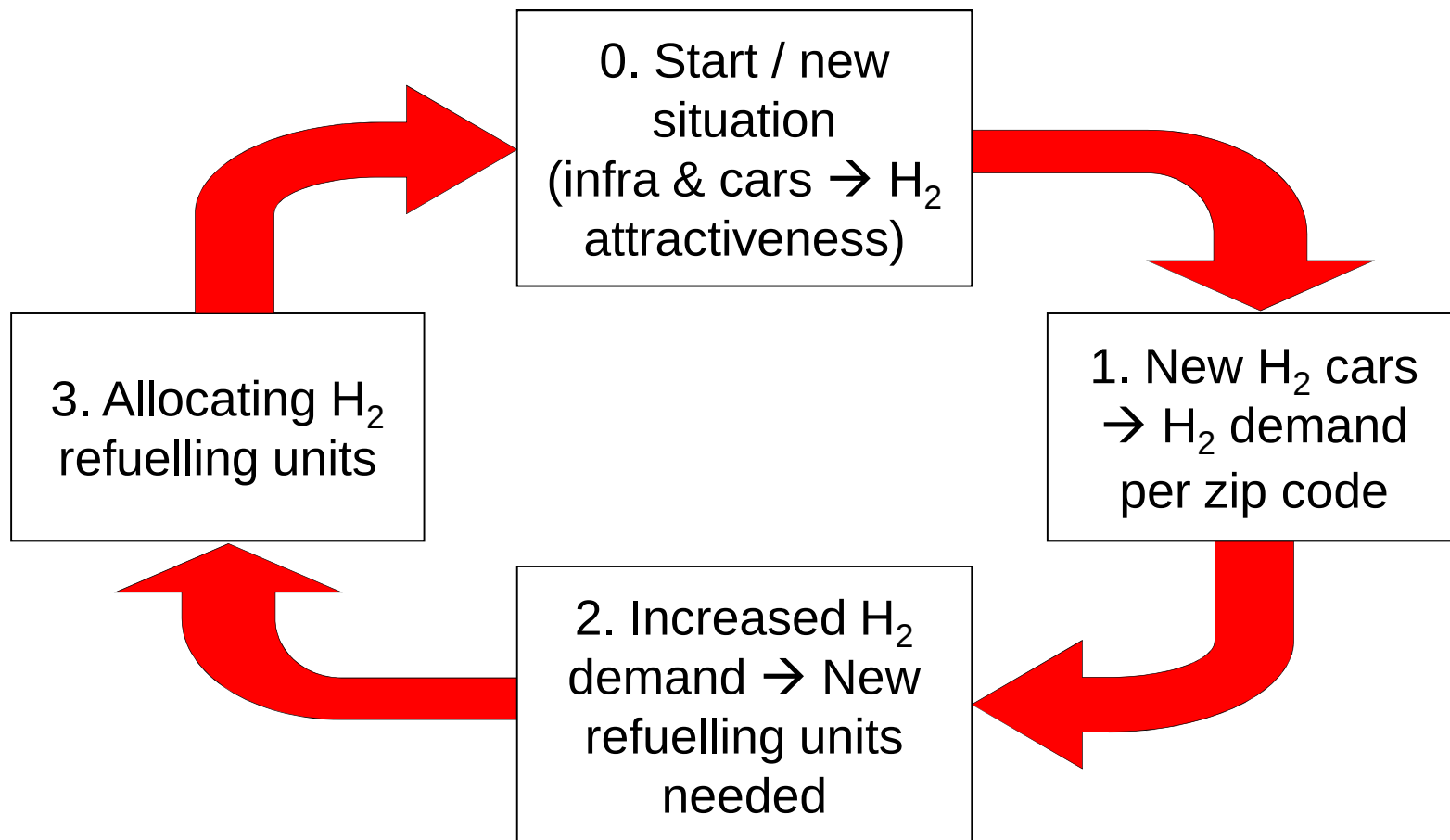
Real world: 4 main actors, many factors...

- Consumers purchase cars based on:
 - Characteristics (brand, model, space, range, etc)
 - Local fuel availability
 - Countrywide fuel availability
 - Price & efficiency of car and fuel (€/km)
 - ...
- Influenced by:
 - Car manufacturers: car availability & price
 - Fuel suppliers: fuel availability & price
 - Policy makers: regulation, taxes and subsidies

THRIVE Rollout Simulation Model – Starting Points

- 4-digit zip codes within NL & Drive time between zip codes
- Number of non-hydrogen vehicles
 - per zip code (ZC) & total increase of passenger car fleet
- Current conventional refuelling station network
 - Integration of H₂ in existing stations
 - zip codes and characteristics
- Current refuelling behaviour
- Car market statistics

THRIVE Rollout Simulation Model – Approach



Overview

- Introduction THRIVE project
- THRIVE ALLOCATE – rollout simulation model

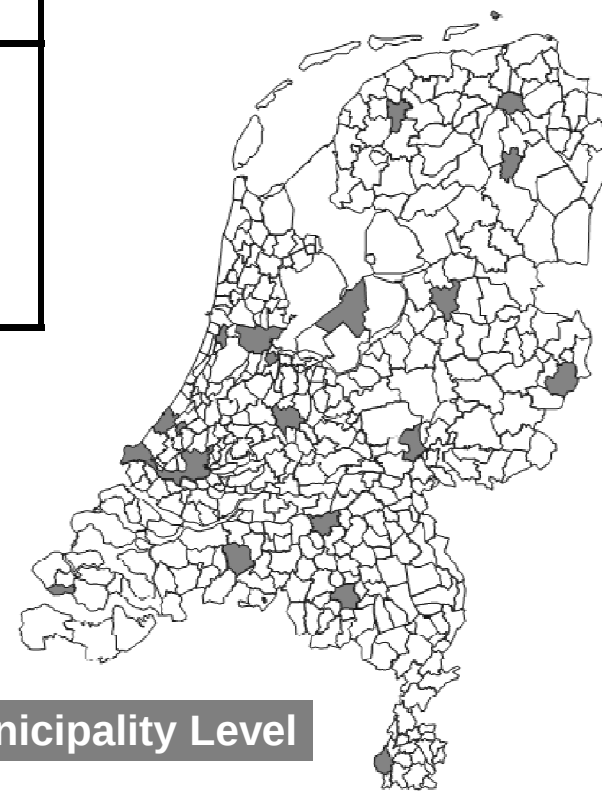
- **Results**

- Sensitivities
- Conclusions

Fuel supplier strategy: Initial network

Careful	Reactive	Proactive
17 seeds in major & capital cities in 2015	17 seeds + 22 seeds 2017 22 seeds 2019	17 seeds + 22 seeds 2016 22 seeds 2017 44 seeds 2019

Initial 17 in 2015

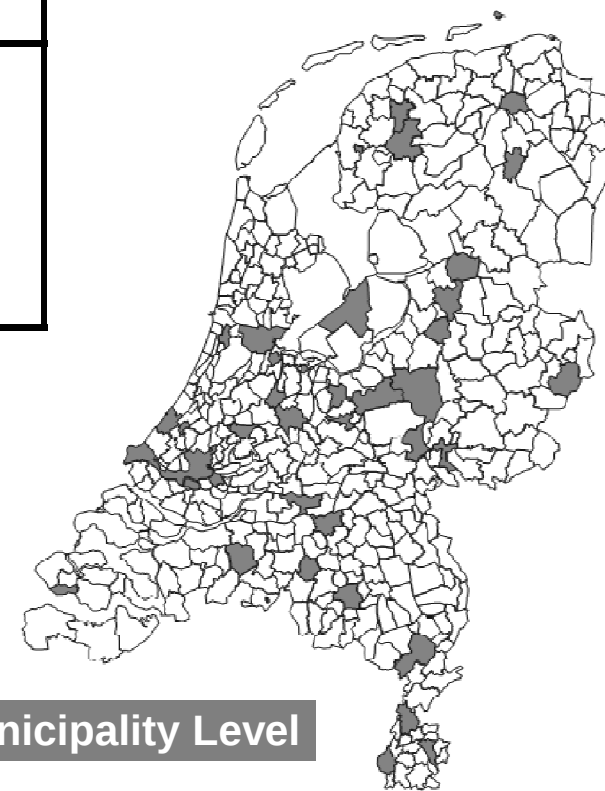


Municipality Level

Fuel supplier strategy: Initial network

Careful	Reactive	Proactive
17 seeds in major & capital cities in 2015	17 seeds + 22 seeds 2017 22 seeds 2019	17 seeds + 22 seeds 2016 22 seeds 2017 44 seeds 2019

+22 = 39

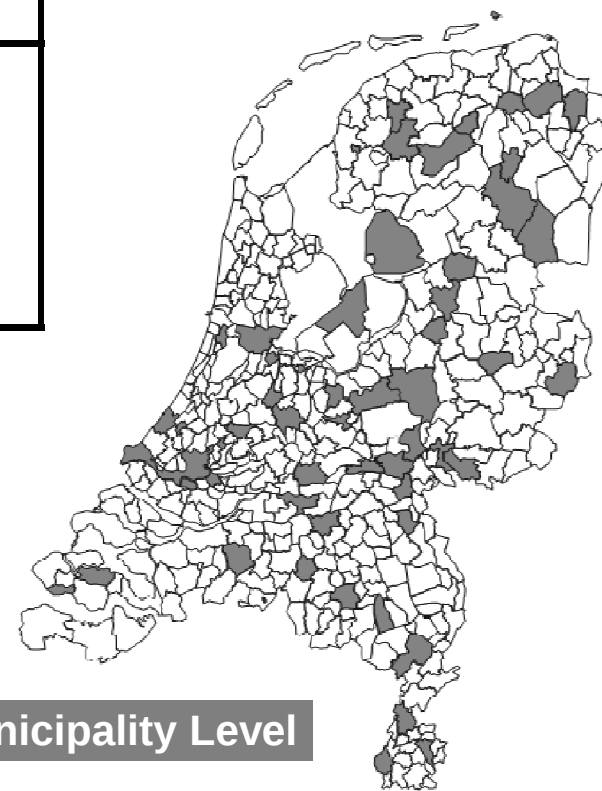


Municipality Level

Fuel supplier strategy: Initial network

Careful	Reactive	Proactive
17 seeds in major & capital cities in 2015	17 seeds + 22 seeds 2017 22 seeds 2019	17 seeds + 22 seeds 2016 22 seeds 2017 44 seeds 2019

+22 = 61

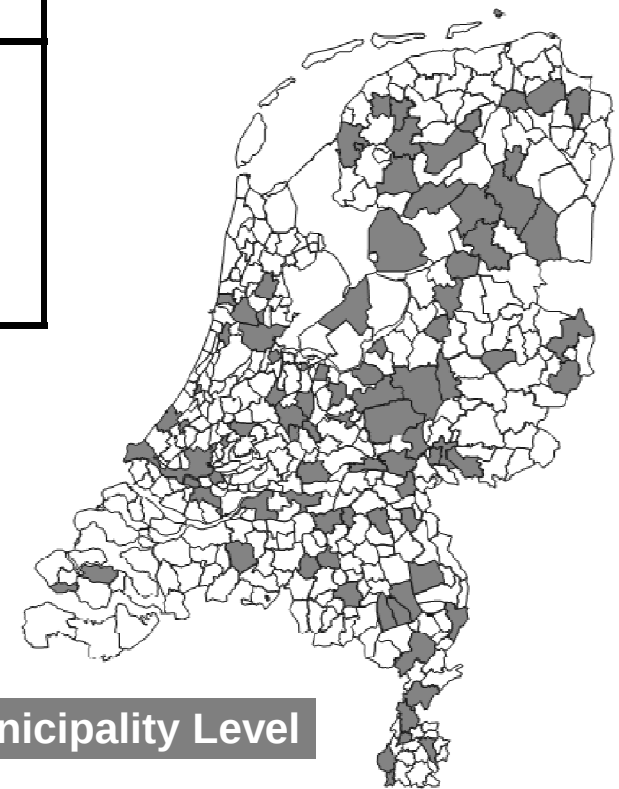


Municipality Level

Fuel supplier strategy: Initial network

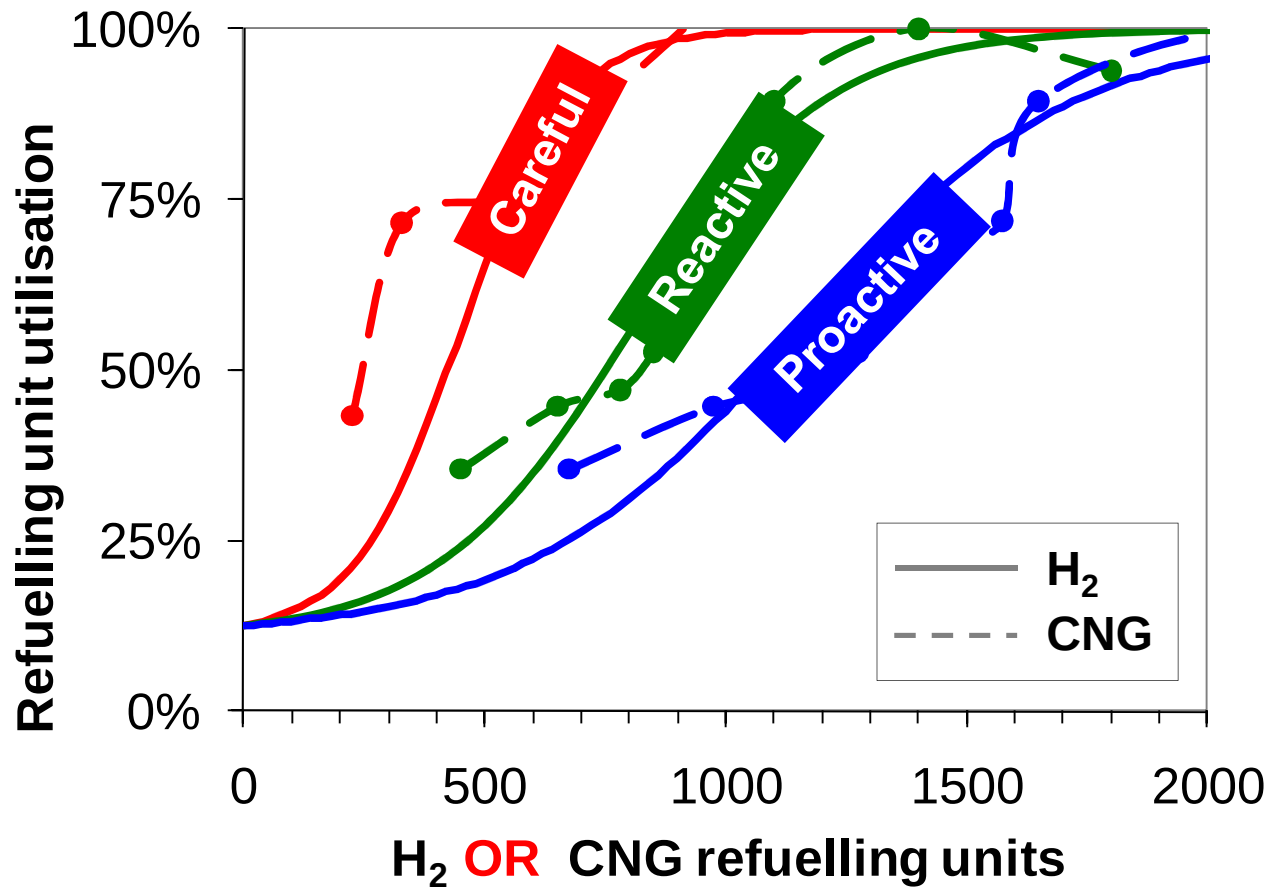
Careful	Reactive	Proactive
17 seeds in major & capital cities in 2015	17 seeds + 22 seeds 2017 22 seeds 2019	17 seeds + 22 seeds 2016 22 seeds 2017 44 seeds 2019

+44 = 105



Municipality Level

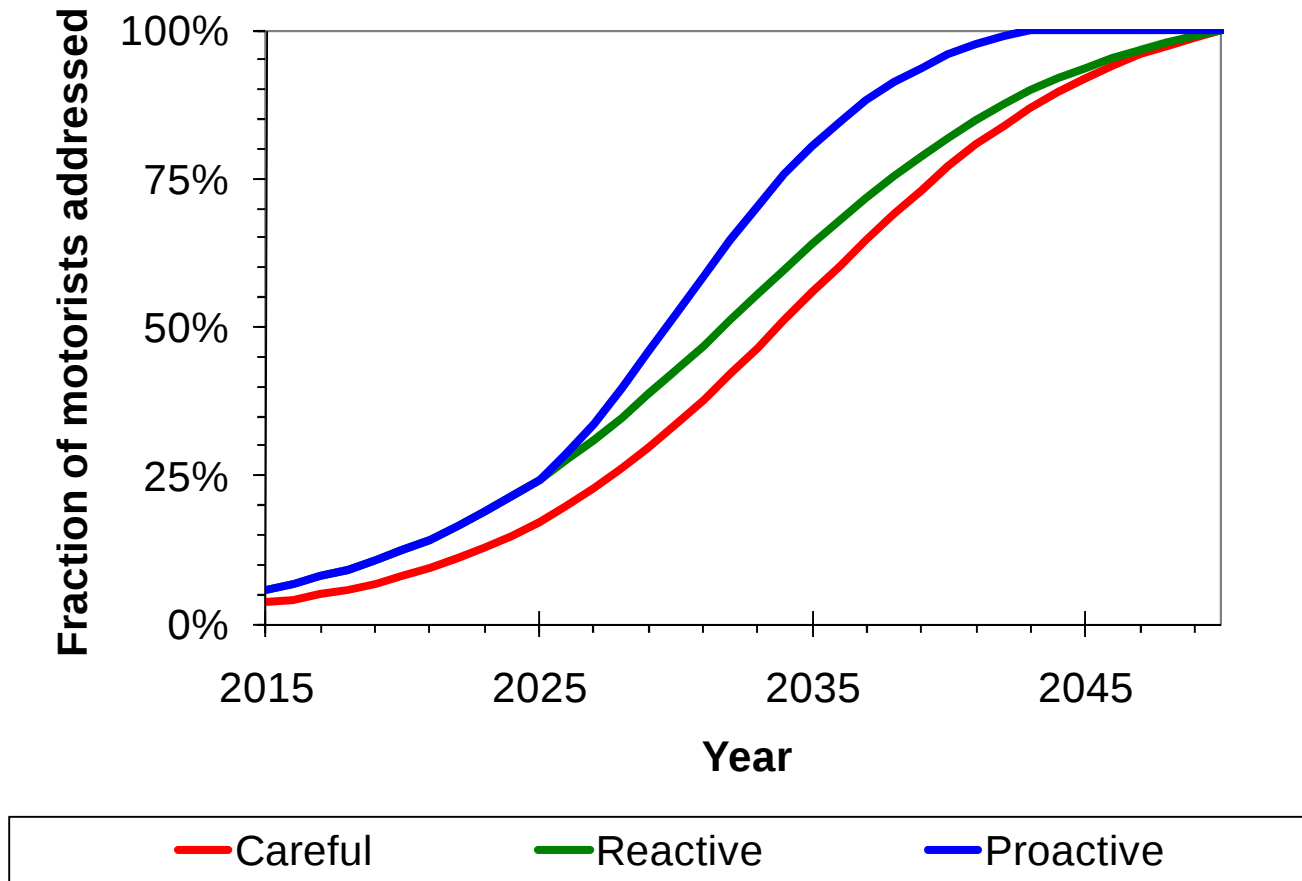
Fuel supplier strategy: Required Utilisation



Car industry strategy: H₂ car model availability (1)

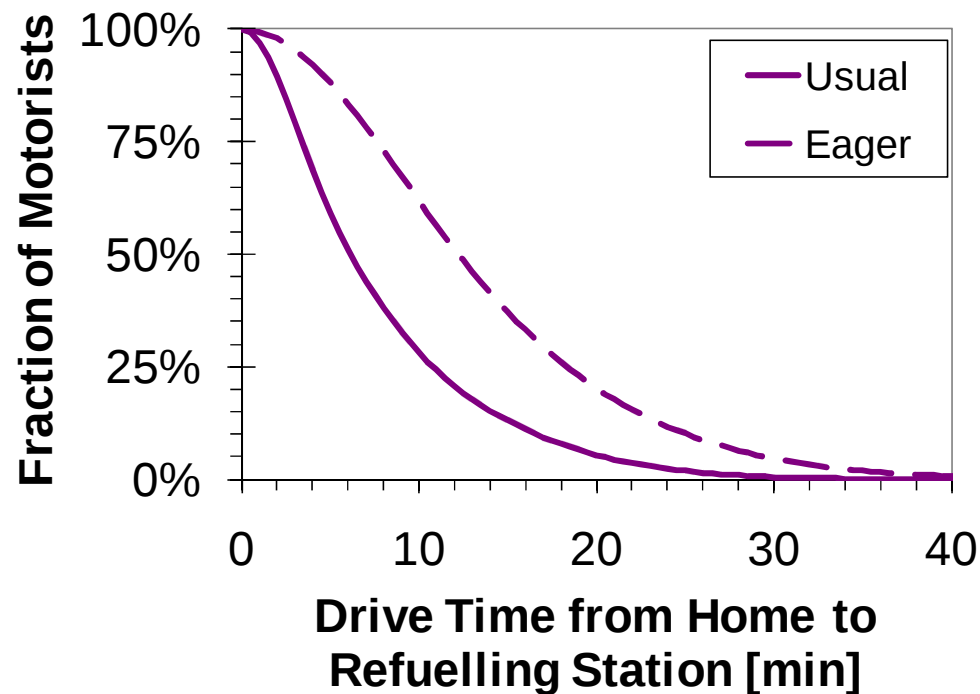
- Car market statistics:
 - 100 models and 20 brands cover around 90% of the market
 - One car model addresses ~1% of all customers
- Assumptions:
 - 6 brands enter market in 2015 with one H₂ car model each
 - By 2030, 20 brands have introduced at least one model
 - Different deployment schemes considered

Car industry strategy: H₂ car model availability (2)



Consumer attitude towards hydrogen

- Usual: Sticks to current refuelling behaviour
- Eager: Willing to change refuelling behaviour



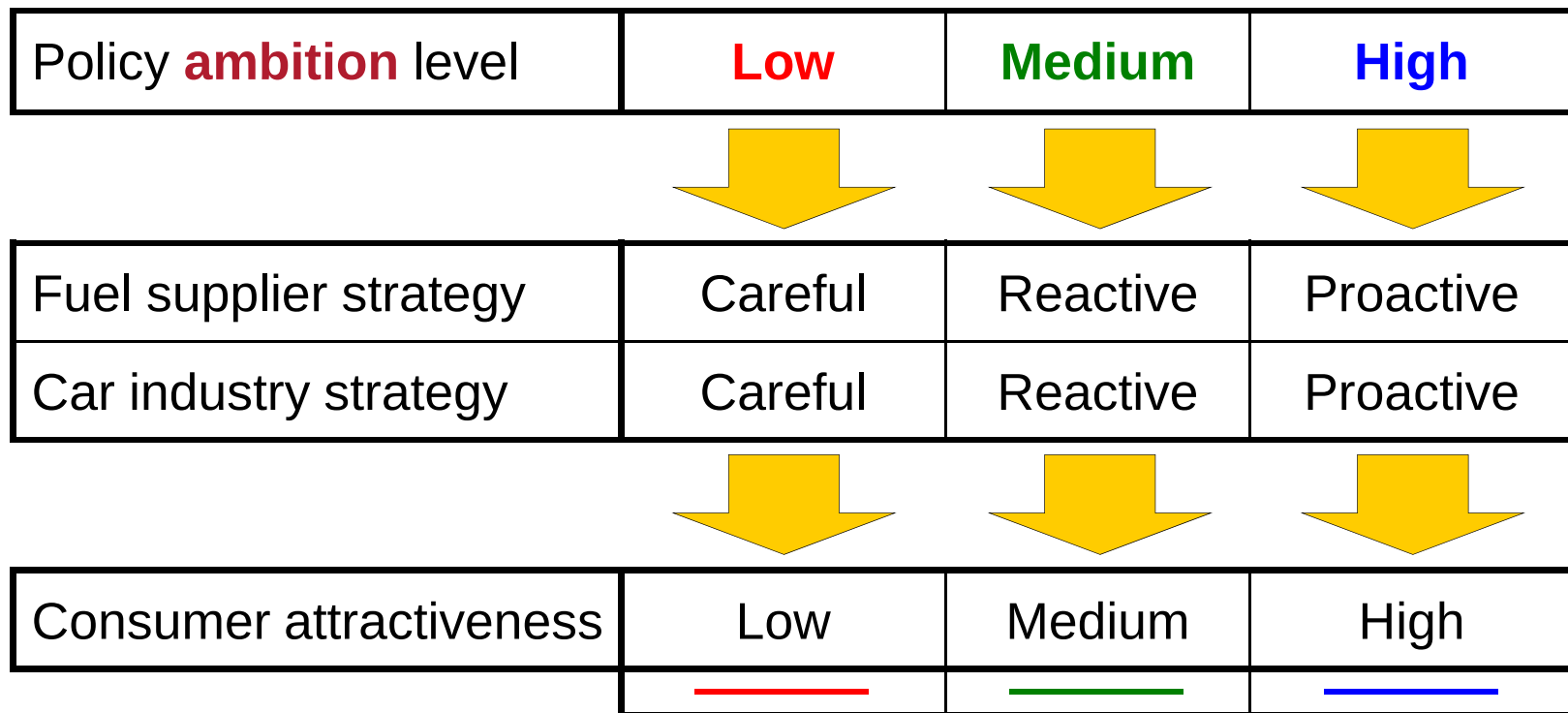
Overview

- Introduction THRIVE project
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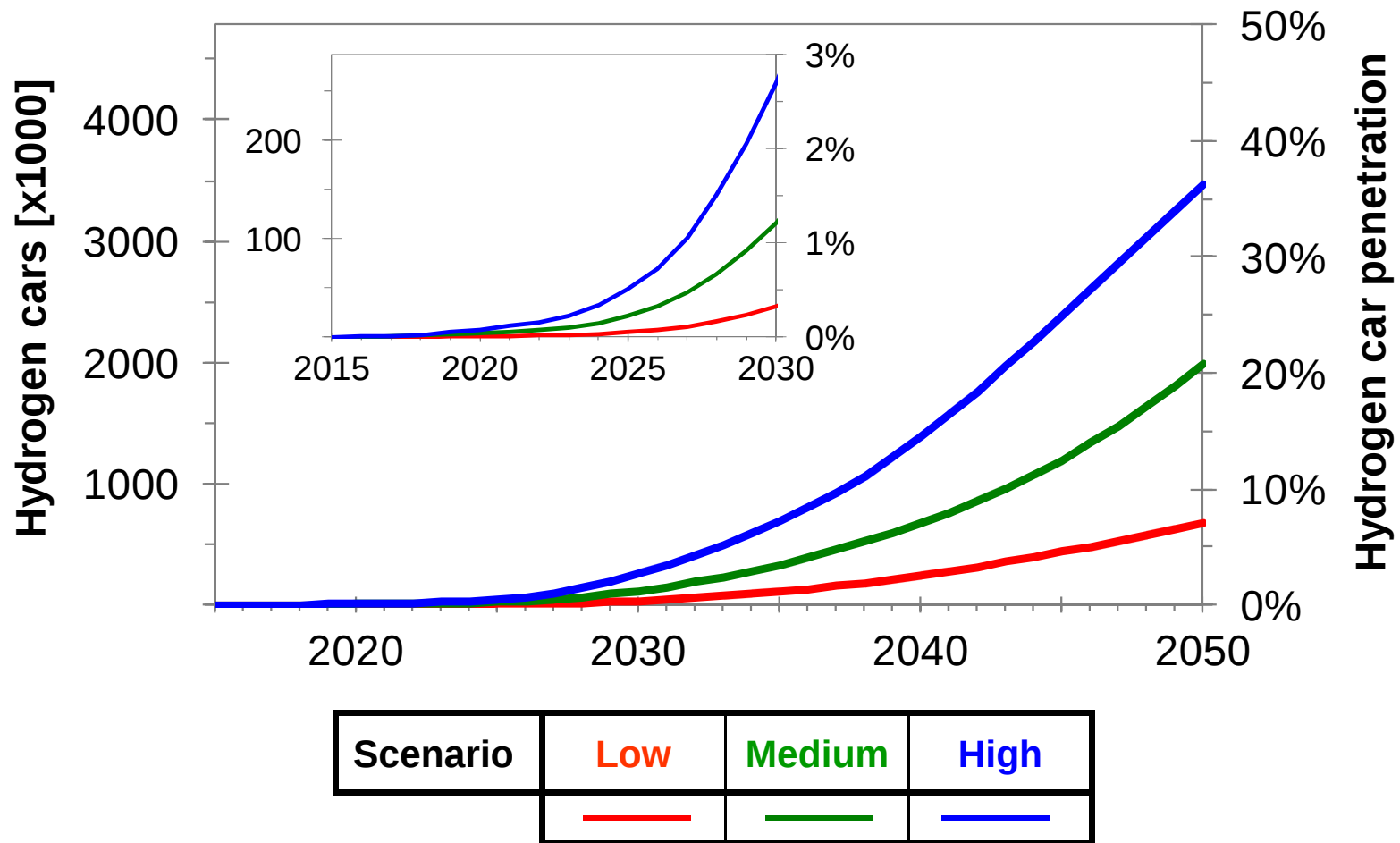
- **Results**

- Sensitivities
- Conclusions

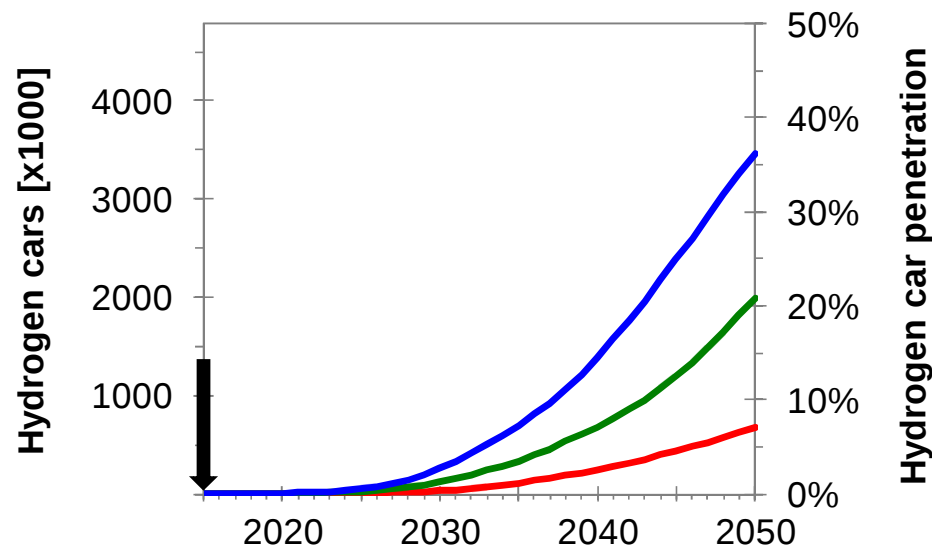
Coherent THRIVE Scenarios



Results – car penetration per scenario

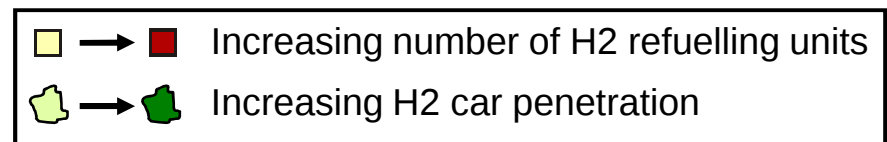


High Scenario



Scenario	Low	Medium	High

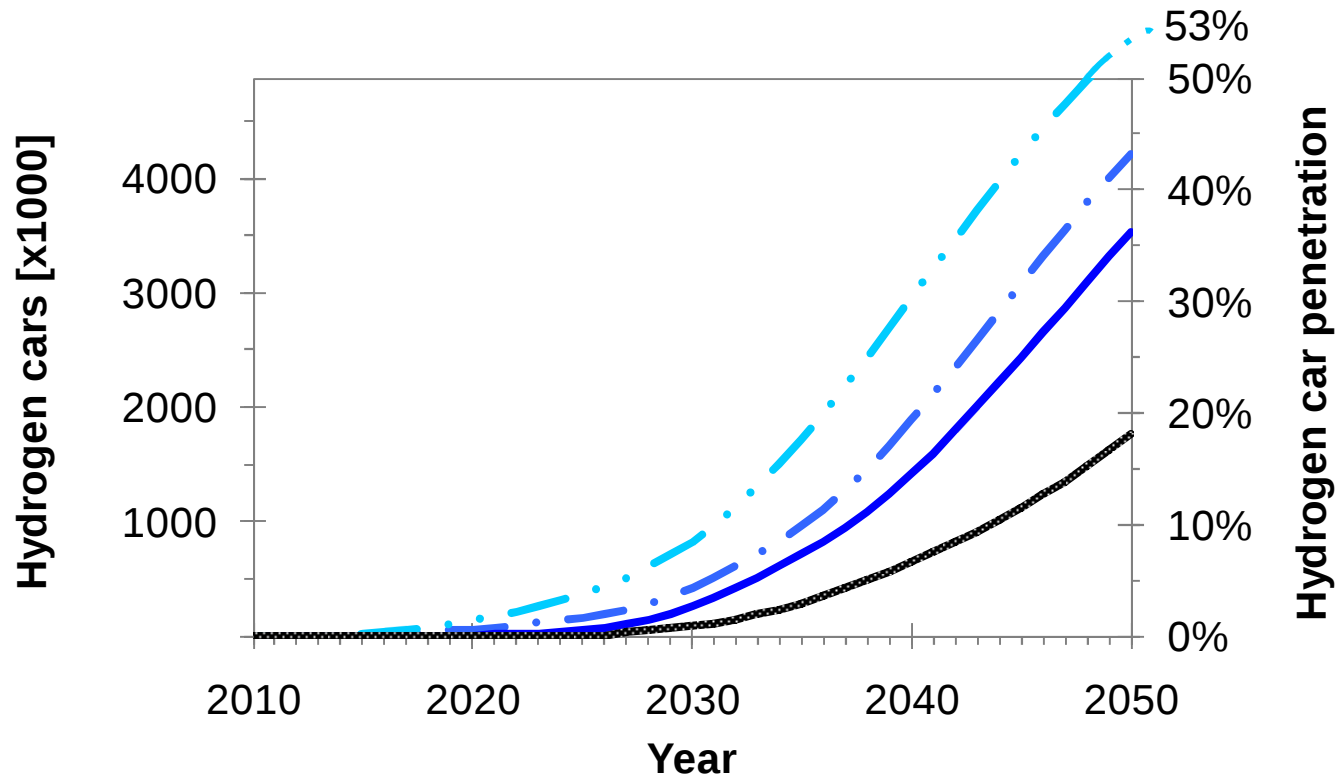
	→		Increasing number of H2 refuelling units
	→		Increasing H2 car penetration

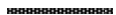


Overview

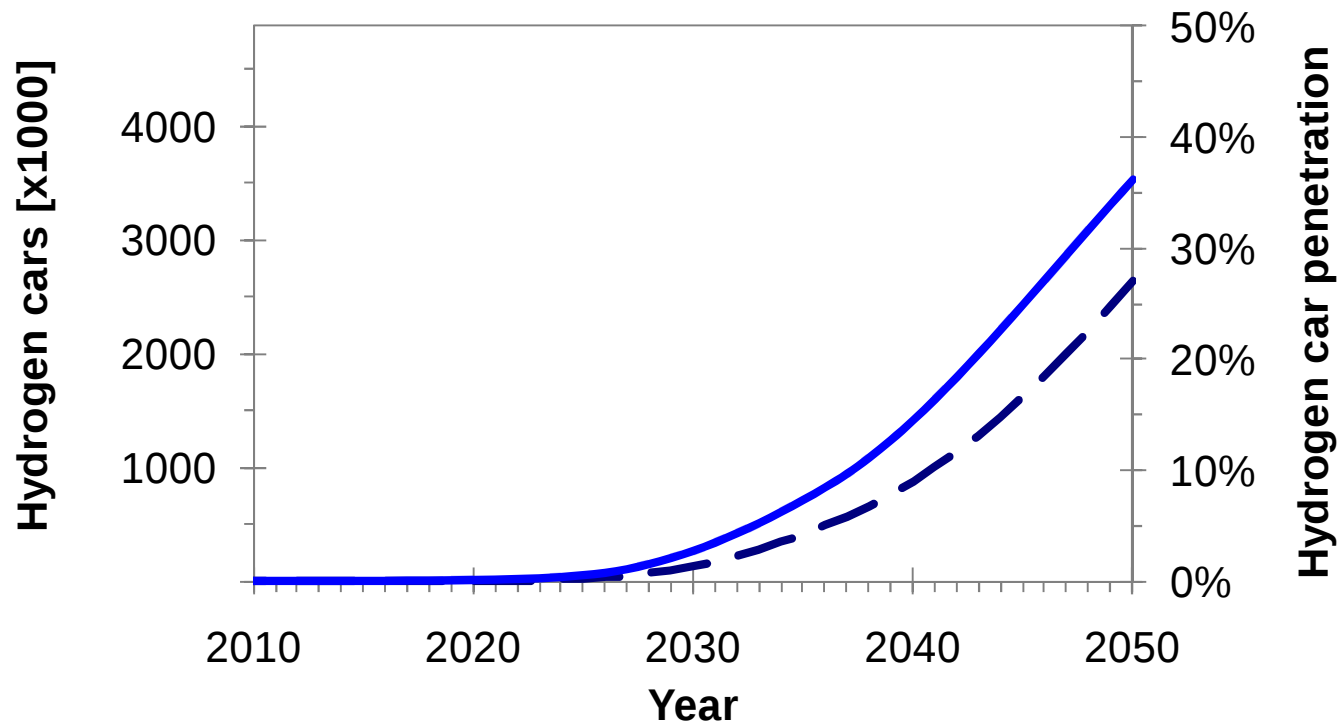
- Introduction THRIVE project
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Sensitivity – Enlarge initial network = more seeds



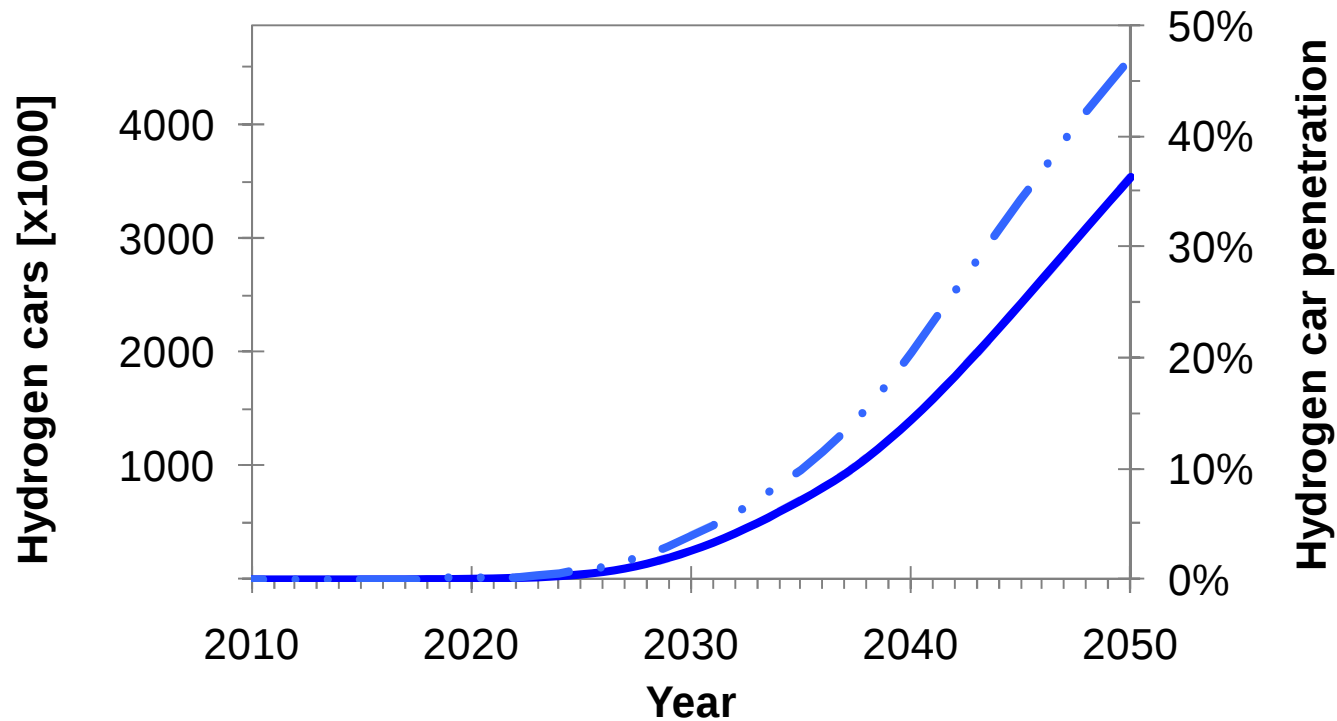
Scenario	High			
Seeding	17	105	361	2185
				

Sensitivity – H₂ car model availability



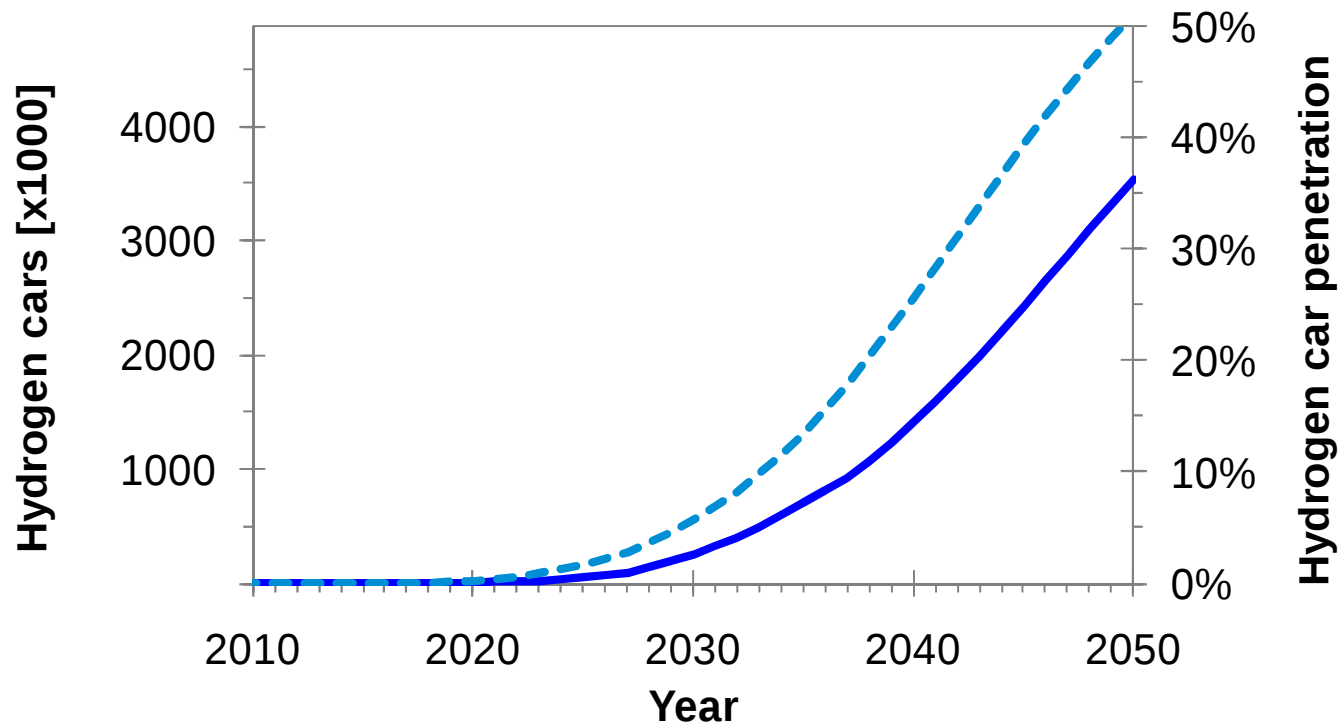
Scenario	High	
Car model deployment	Delayed (careful)	Energetic (proactive)
	— — — —	—————

Sensitivity – effect of lease car market



Scenario	High	
Considered market	private cars only	private & lease cars
		

Sensitivity – consumer attitude



Scenario	High	
Consumer attitude	Usual	Eager
		

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- **Conclusions**

Conclusions

- THRIVE presents an integrated perspective for rollout of H₂ cars and corresponding refuelling infrastructure
- THRIVE simulates consumer-driven rollout influenced by industry market strategies, which reflect different policy settings
- Meaningful penetration requires:
 - Widespread upfront availability and visibility of H₂ stations
 - Fast expansion of hydrogen refuelling station network
 - Rapid deployment of different H₂ car models
 - Introduction of cars via lease car market
 - ... and may accelerate if motorists become tempted to change habits
- Simulations indicate that by 2050, up to 55% of all cars could run on hydrogen

THRIVE presentations

Day	Session	Time	Room	Presenter	Title
Tu.	HP.6	11:30	Mailand	Hoevenaars	Hydrogen vehicle deployment and required policy support for rollout scenarios in the Netherlands
Tu.	TA.4	12:00	Room L	Lebutsch	Impact of industry strategies and consumer attitude on growth of the H ₂ vehicle fleet & refuelling infrastructure
Tu.	SA.3	15:00	Room S+T	Bunzeck	Building a H ₂ refuelling infrastructure in the Netherlands: influencing factors from the car drivers' perspective
Tu.	HI.2	13:00 & 17:30	Poster exhibition Hall 3	Lebutsch / Weeda	THRIVE ALLOCATE – A dynamic model to simulate rollout of hydrogen vehicles and refuelling infrastructure
Th.	HI.1	8:30	Berlin	Weeda	Cost analysis of H ₂ refuelling infra rollout scenarios in the Dutch THRIVE project



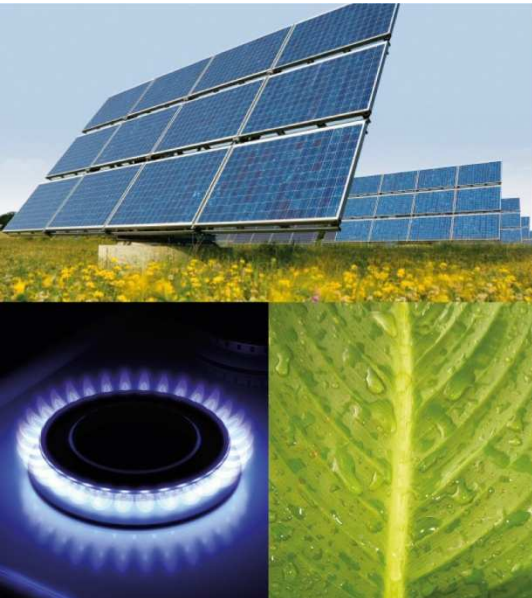
Energy research Centre of the Netherlands



The THRIVE consortium gratefully acknowledges the Ministry of Economic Affairs and Agentschap NL for their financial support



Agentschap NL
Ministerie van Economische Zaken



Towards a Hydrogen Refuelling Infrastructure for VEHICLES

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