ECN

Energy research Centre of the Netherlands

Towards a low carbon transport sector: electricity or hydrogen?

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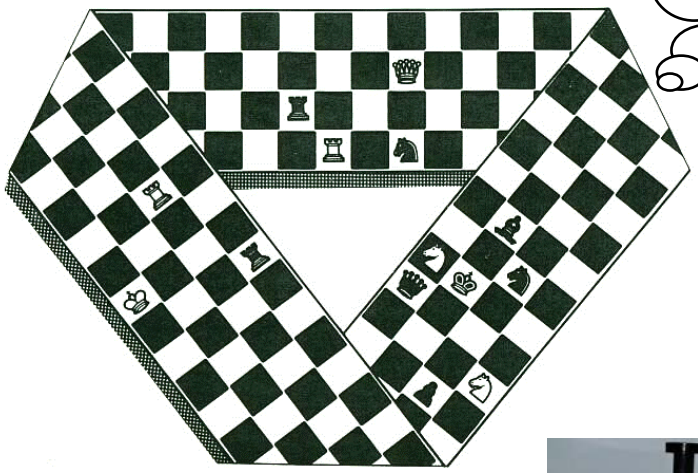
Overview

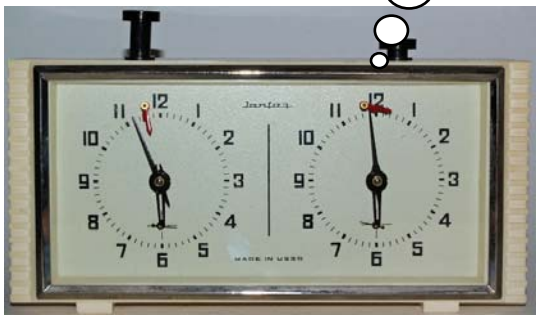
- Introduction
- Two possible innovations:
  - Electric vehicles
  - Hydrogen fuel cell vehicles
- Results Dutch case study
- Conclusions

A transition to a low-carbon transport sector is like a game of chess



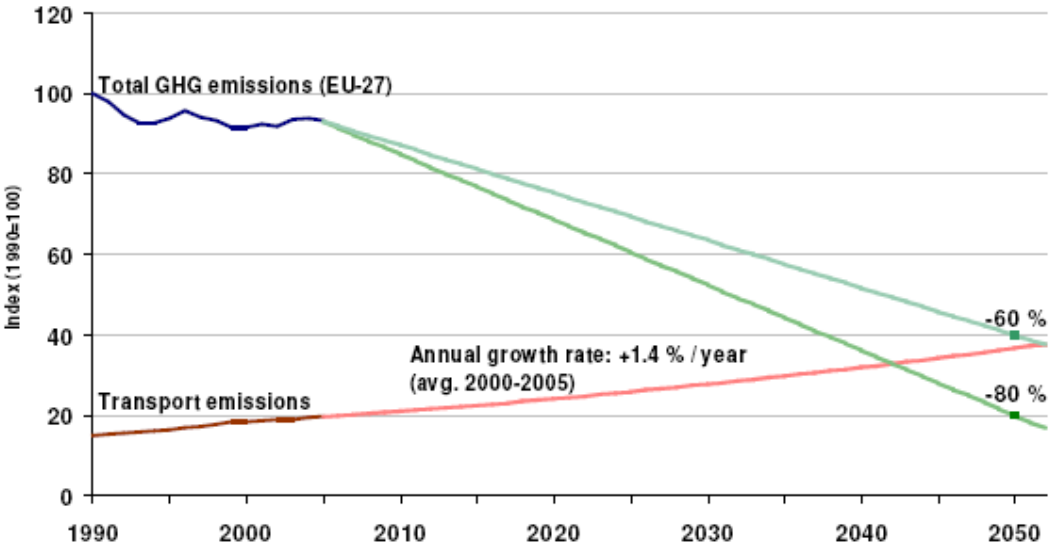
Consumer, industry, government

2010?
2030?
2050?



We know why we play the game…

- Substantial GHG emission reductions needed to limit global warming
- We are running out of (cheap) fossil fuel

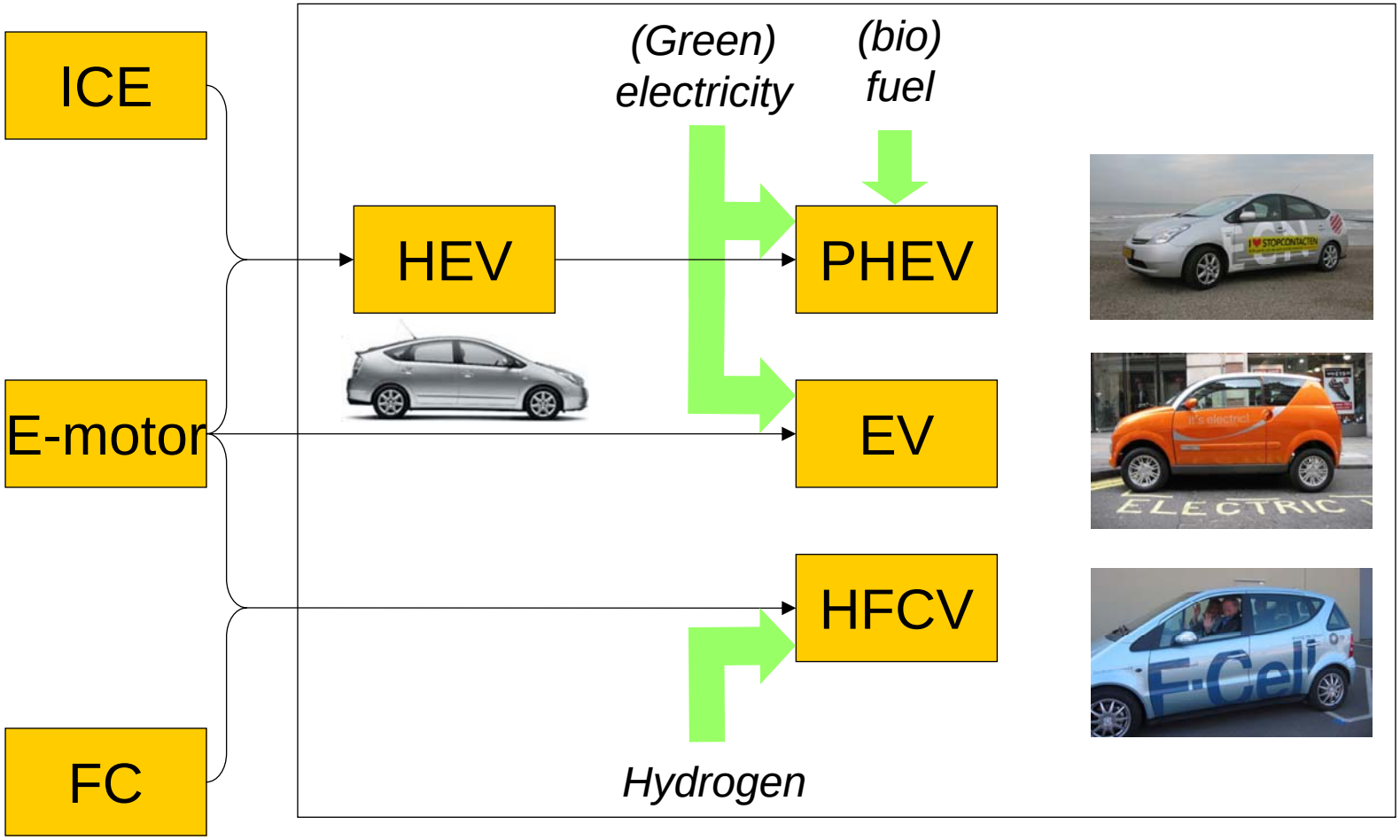


Source: European Environment Agency, 2009

… and we have options on different levels

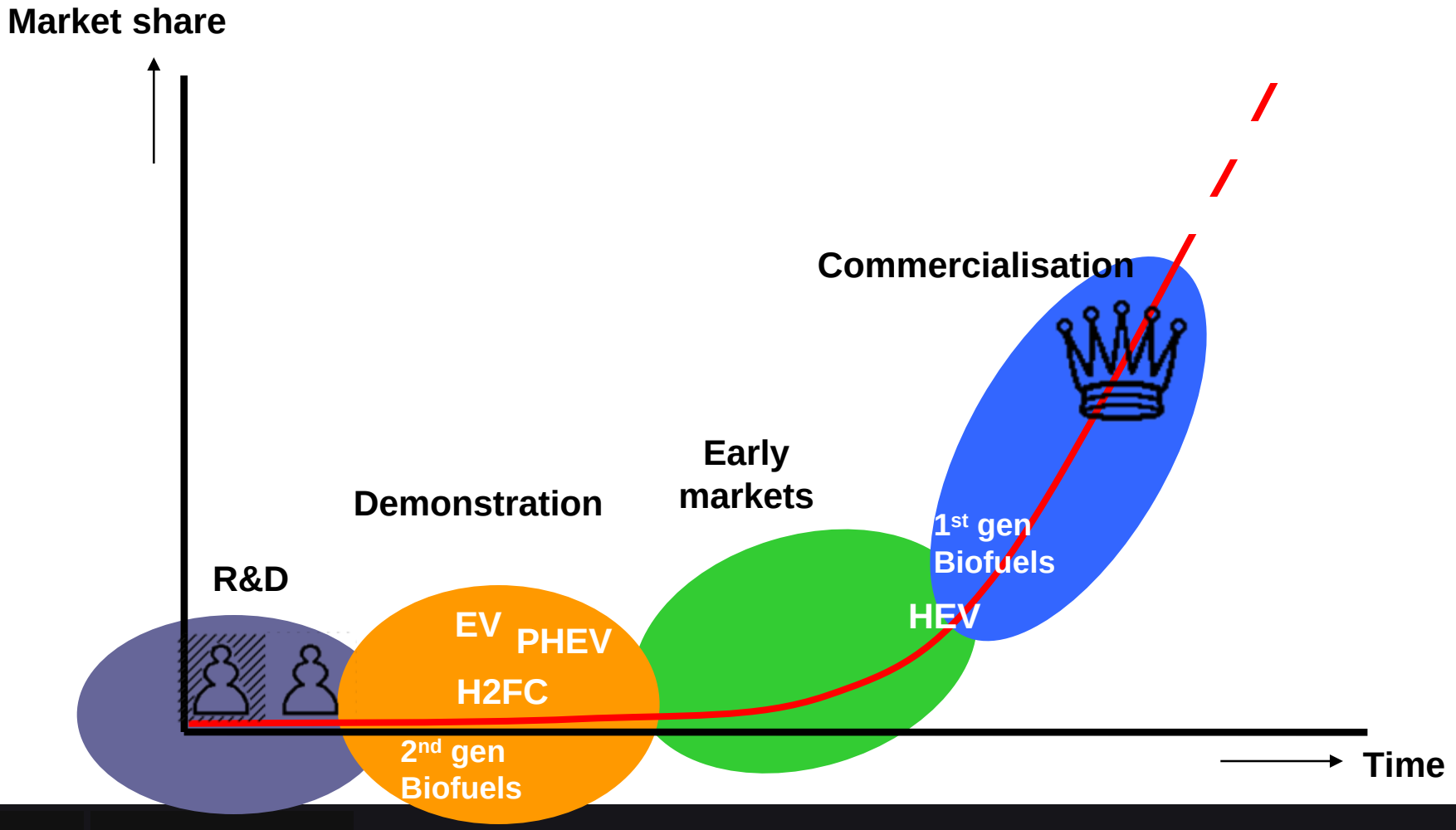
1. Reduce transport demand
2. Improve transport efficiency
3. Improve driving behaviour
4. Improve vehicle efficiency
5. Use low carbon fuels

Several innovative concepts available



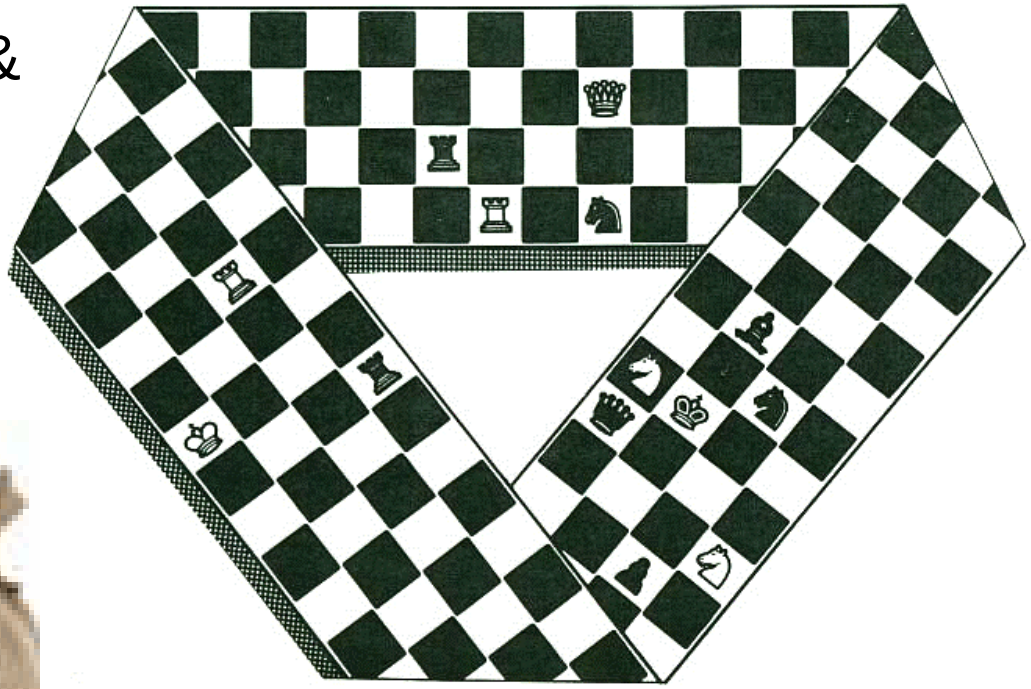
ICE: internal combustion engine; FC: fuel cell; HEV: hybrid-electric vehicle; PHEV: plug-in hybrid-electric vehicle; EV: electric vehicle; HFCV: hydrogen fuel cell vehicle

The innovation cycle: from pawn to queen



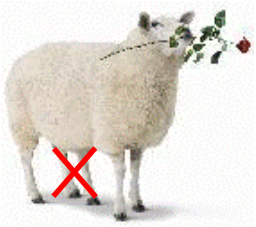
Different innovations - different barriers

Technology & range



Fuel infrastructure

Vested interests and new actors



Acceptance consumer

Sustainable innovation in road transport: Dutch case study on innovation scenarios

- Limited to Dutch road transport
- Primarily from a sector perspective…
- … but including chain effects
- Limited set of innovations
- Ambitious, but realistic scenario approach

A closer look - hydrogen FC vehicle

H_2 infrastructure

Several filling stations

Initially: liquid H_2 distribution in trucks
Pipelines around 2030

National coverage

Technology development

Prototype phase

R&D
Demonstration projects
Early markets

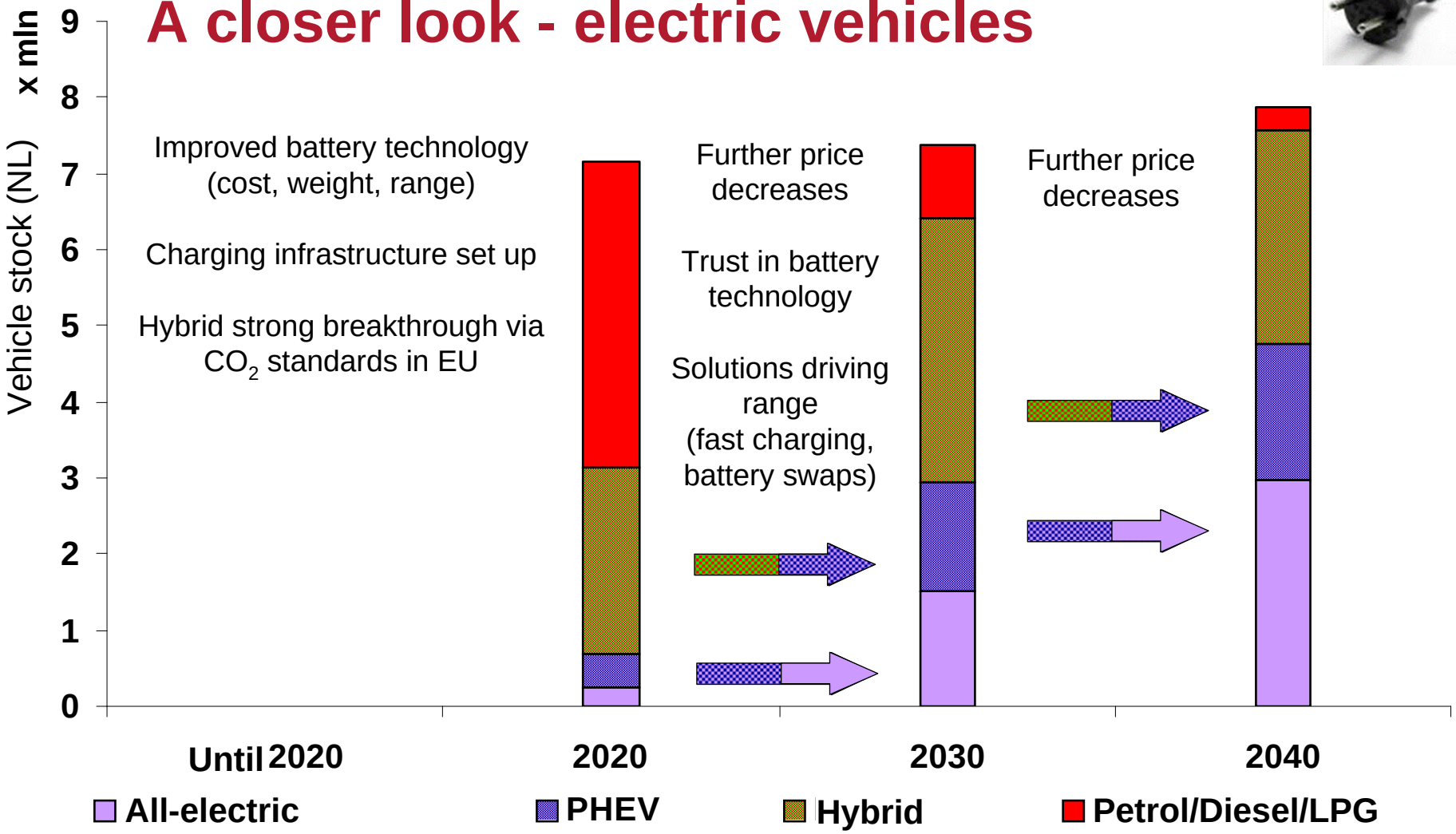
Mass production

"Disruptive technology"
Breaks through or not
Needs coordination!

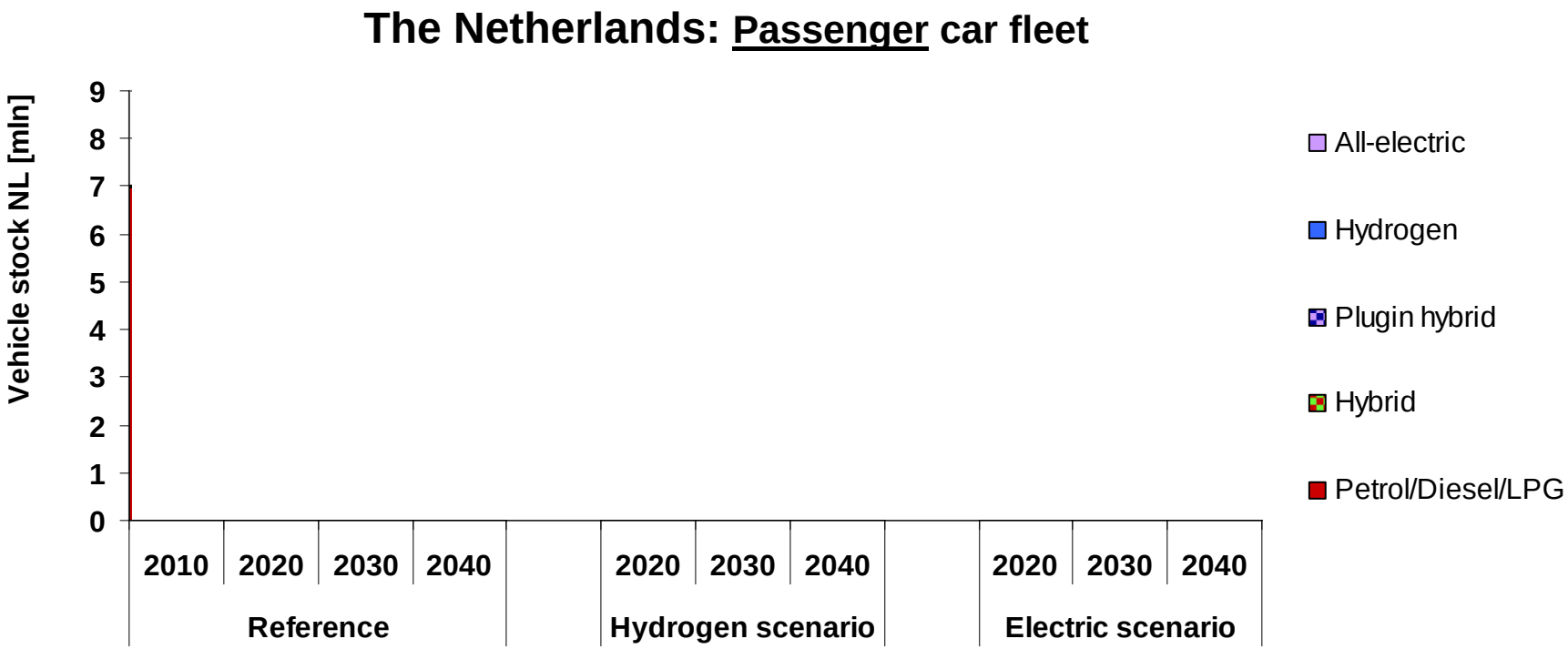
Development market

Initial high cost of vehicle
Success of alternatives (lock-in)

A closer look - electric vehicles

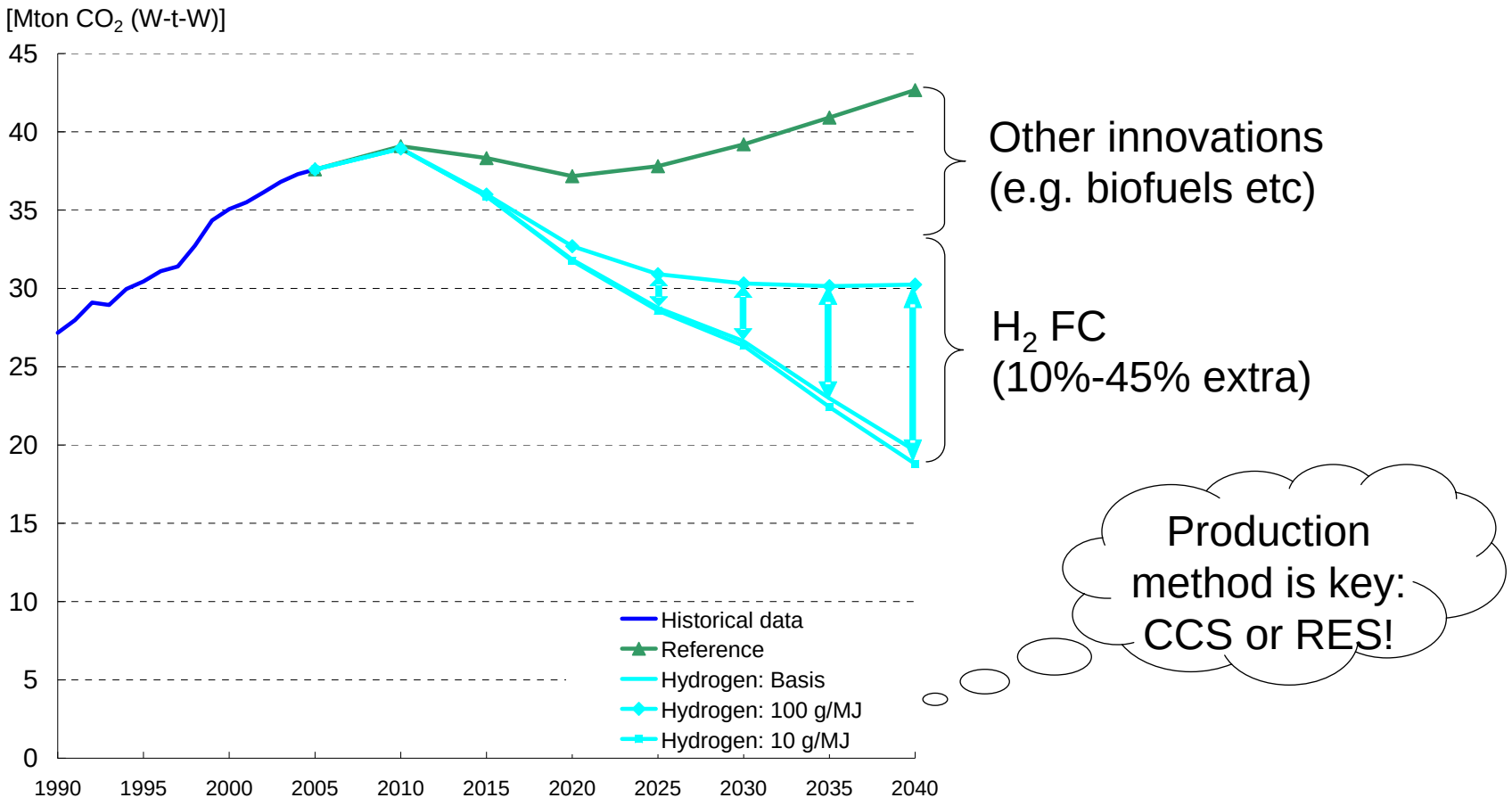


Overview innovation scenarios

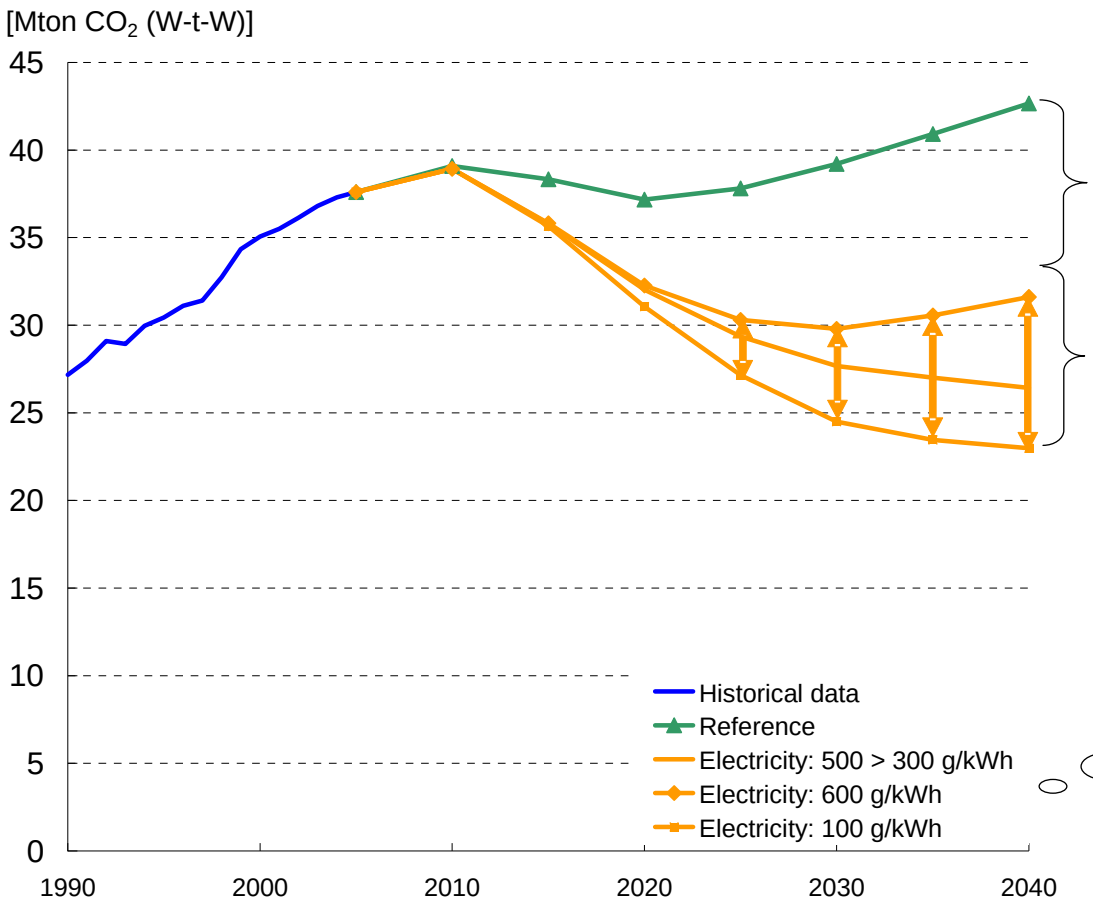


Both scenarios also contain 20-30% biofuels and some energy saving innovations

Well-to-Wheel CO_2 emission - hydrogen



Well-to-Wheel CO_2 emission - electric



Other innovations
(e.g. biofuels etc)

EV and PHEV
(5%-25% extra)

Production method is key: CCS or RES!

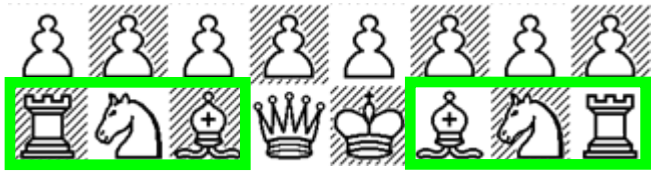
Conclusions on electricity and hydrogen

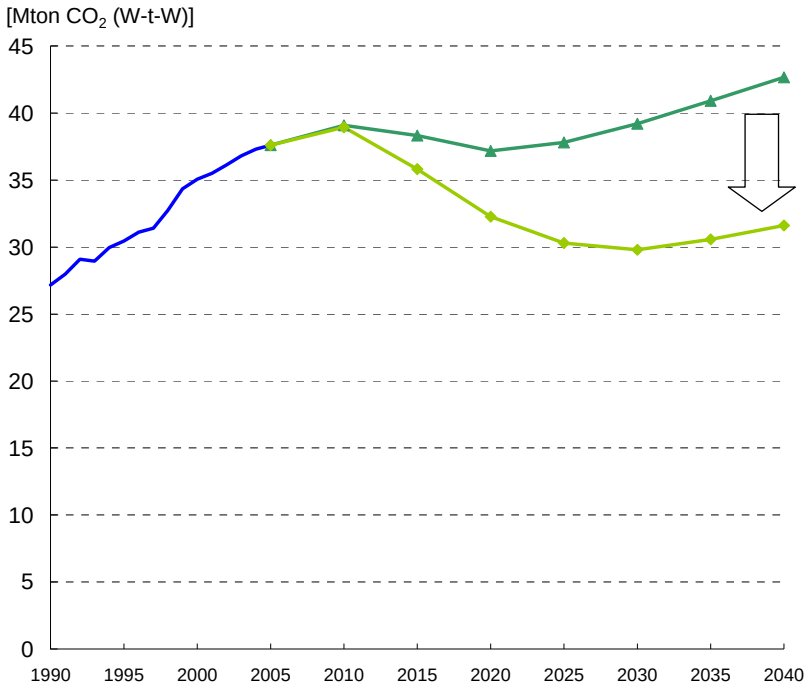
- Both innovations offer a potential winner:
  - Efficiency gain compared to ICE
  - Zero direct emissions
  - Diversification
- … but they are not ready yet
- For low well-to-wheel emissions CCS or renewables are essential

Towards a low carbon transport sector: Is there a winning strategy?

First phase: Use available technology

- Proven technology
- (Nearly) in commercialisation
- Examples:
  - Improve ICE, incl hybrids
  - Biofuels (limited)

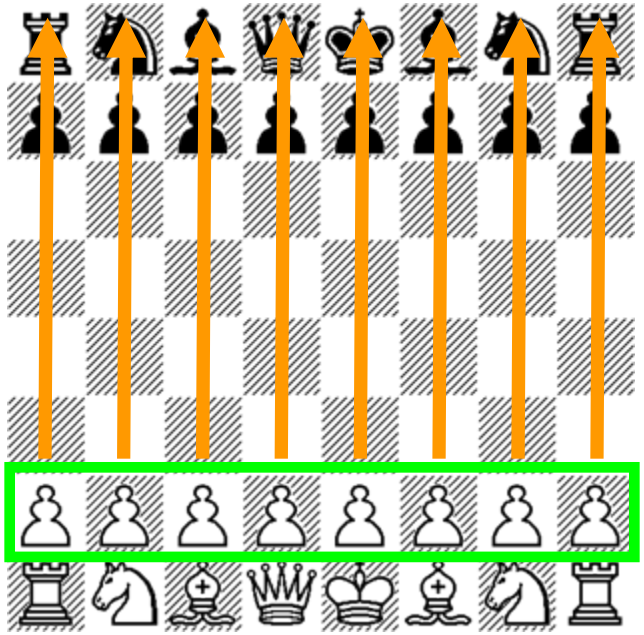


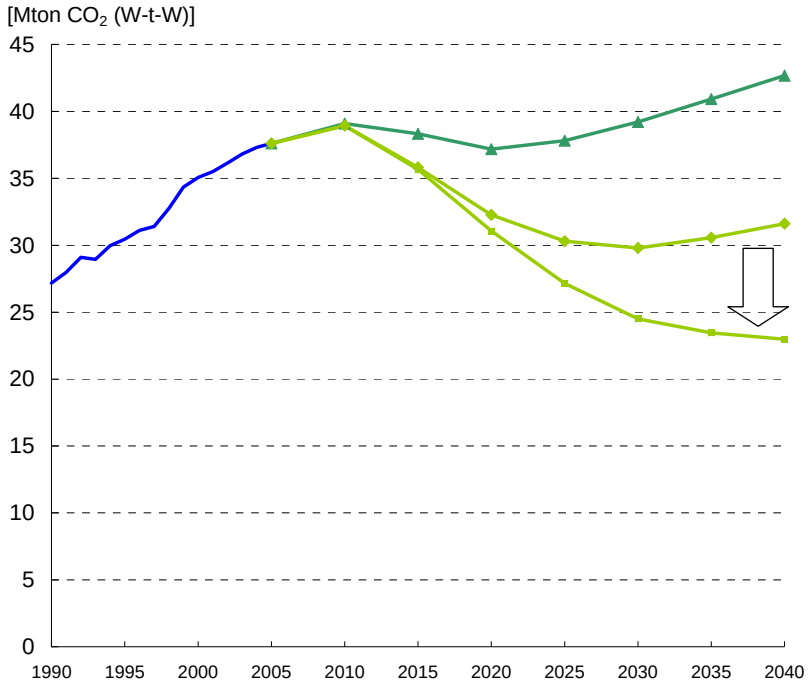


Towards a low carbon transport sector: Is there a winning strategy?

Second phase: Develop the long-term winner

- Support hydrogen and electric by large demonstration projects
- “Wait and see” which pawn becomes the next queen

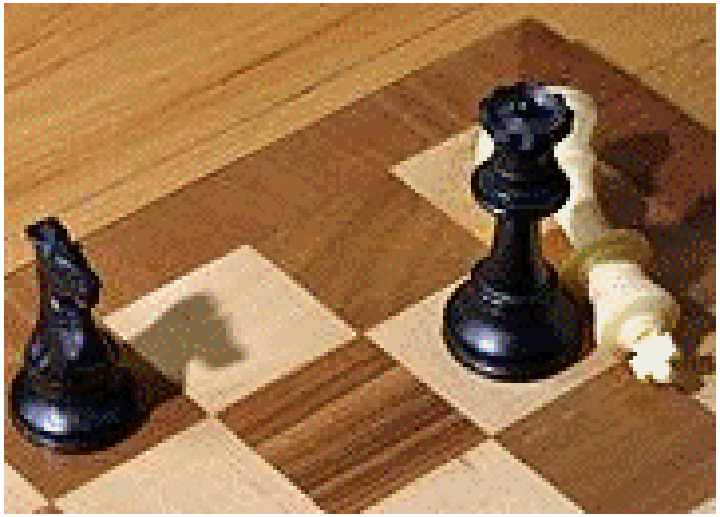




Conclusions

- In a low carbon transport sector, electric or hydrogen fuel cell vehicles are the future of passenger transport
- Potential CO_2 emission reduction substantial, but strongly depends on the method of production
- The long term winner is not clear yet: All candidates (electric, plug-ins or hydrogen fuel cell) are still in demonstration phase and require a system innovation
- Until winner is clear:
  - use available technology to reduce emissions ICE (EE & RE)
  - support development of all potential long term winners

Thank you! Any questions?



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Comparison hydrogen and electricity

	Hydrogen	Electricity
Energy density (kWh/kg)	1,7 Diesel: 12	0,13
Consumer acceptance	Refuel in minutes; Perception less safe?	Long recharge time Driving range
Scarce resource	Platina	Lithium
System innovation required	Production,storage and distribution	Distribution (strengthening existing grid)
New actors	Oil companies	Electricity suppliers New business concepts
Production method	CCS essential or renewables	Renewables Fossil fuels + CCS