Hydrogen

The gold medallist on system integration

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Objectives of the Roadmap

On request of the Ministry of Economic Affairs and Climate a hydrogen roadmap was made.

Objectives:

• Indicate the potential of hydrogen in a sustainable energy system in 2050

• Give an overview of actors and activities on hydrogen in the Netherlands

• Advise what steps should be taken and which activities are necessary to realise the potential of hydrogen

Approach:

• f2f meetings, workshops, documents
Markets for hydrogen

RES imported as H₂ compound

Fuel cell electric vehicles

Synthetic fuel

Refining of oil/biomass

Feedstock for chemical sector including NH₃

Manufacture and processing of steel

Various applications as an industrial gas

Heating for built environment

High-value heat for industry
Clean transport in and around cities:
Public transport, taxis, carbage trucks, sweepers, boats, …
Green hydrogen and climate neutral carbon: green chemicals
Hydrogen production

- Wind
- Solar PV
- Exchange for import/export
- Power stations
- Electricity storage

Electricity grid
Production and utilisation of hydrogen

Electricity grid

Power stations

Hydrogen from electrolysis

Hydrogen (natural gas) infrastructure

TKI NIEUW GAS
Topsector Energie
Centralised $\text{H}_2$ production with CCS: decarbonising $\text{CH}_4$ with adapted infrastructure and decentralised utilisation
It’s the system, stupid!
However, important (innovation) challenges to mention a few…

1. **Cost price reduction and technology improvement** to reduce the cost of hydrogen

   *Components and systems*

2. **Green electricity** for green hydrogen

   *More, more, more*

3. **Support for CCS** to produce blue hydrogen

   *It is possible, but is it accepted?*

4. **Financial support**

   *To bridge the gap with fossil fuel based alternatives*

5. **Institutional conditions** need to be tackled

   *Rules and regulations, safety, public support etc*
Action plan for hydrogen

‘Hydrogen Transition Programme’

1. Integral plan and vision for hydrogen (next 3-5 yrs, towards 2050)
2. Hydrogen pilots en demos (starting now)
3. R&D for hydrogen (fundamental and practical, fitting Dutch strengths)

Coordination and facilitation of hydrogen (next 5 yrs)
Indicative roadmap
Where are we and what is our direction?

1. Mobiliteit & transport
   - Personenauto's
   - OV-bussen
   - Bestelauto's
   - Vrachtwagens
   - Touring cars
   - Vorkheftrucks
   - Specialty voertuigen
   - Binnenvaart / boten

2. Industrie grondstof
   - Huidige gebruik industriële H₂: ammoniak, raffinaderij, etc.
   - Duurzame chemie o.b.v H₂ en CO₂ voor lucht- en scheepvaart

3. Industrie proceswarmte
   - Hoge temperatuur proceswarmte
   - Low-carbon ijzer en staalproductie

4. Productie elektriciteit
   - Gasgestookte elektriciteitsproductie

5. Gebouwde omgeving
   - Ruimteverwarming HR-ketel / hybride warmtepomp / micro-WKK

6. Waterstofproductie
   - Aardgas reforming
   - Aardgas reforming / CCS
   - Elektrolyse

Timeline:
- 2020
- 2025
- 2030
- 2035
- 2040
- 2045
Thank you for your attention

Hydrogen Roadmap can be downloaded at: