SHIP>NL
SUSTAINABLE HYDROGEN IMPORT PROGRAM

AGENDA
SHIP>NL SESSIE IV 18 MEI 2022

15:00-15:10 WELKOM EN OPENING

15:10-15:30 TOUR DE TABLE - ACTUALITEITEN

15:30-16:00 DEEP DIVE: FIRST MOVER LANDEN: JAPAN, DUITSLAND EN... NEDERLAND?

16:00-16:50 DISCUSSIE: ROUTEKAART NATIONAAL WATERSTOF PROGRAMMA

16:50-17.00 AFSLUITING

TNO innovation for life

‘HUISREGELS’

- Camera aan, microfoon op ‘mute’
- Vragen?
  - Plaats *verduidelijkingsvragen* in de meeting chat;
  - Steek je hand op

) De moderator zorgt ervoor dat je vraag beantwoord wordt (eventueel achteraf).
- Slides worden na de sessie gedeeld
- TNO maakt een verslag van geïdentificeerde kennisvragen en inzichten; het zal geen specifieke informatie of uitspraken bevatten.
- We bespreken uiteraard geen marktgevoelige zaken.
- Chatham hous rules: De besproken informatie mag gedeeld worden, maar zonder de spreker te onthullen.

MEERJARIG KENNISPROGRAMMA MET 5 LIJNEN

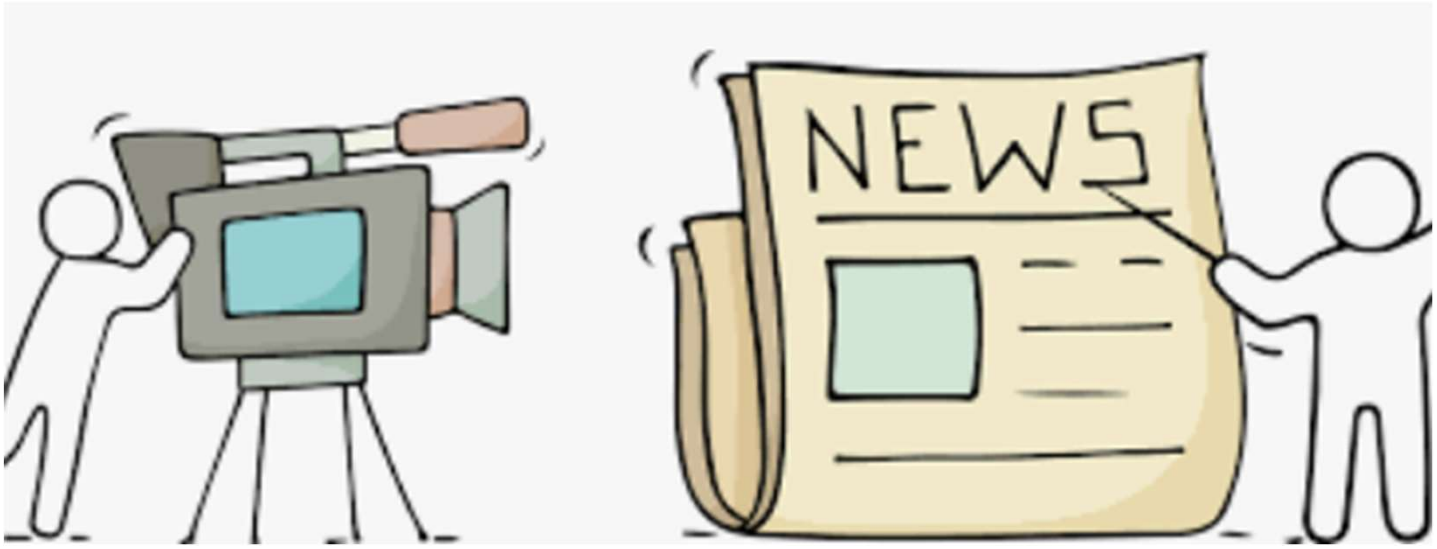
In deze sessie:

1 Technisch economisch	2 Beleid	3 Markt	4 Internationaal	5 Omgeving
▪ Inzicht in importketens productie-conversie-transport-opslag-reconversie-gebruik ▪ Vraagontwikkeling, scenario's ▪ Infrastructuur & systeemintegratie: corridors, benutten bestaande infra. ▪ Technology assessments, R&D	▪ Impact van 'Fit for 55', REDII, Delegated acts, ETS/CBAM, etc. ▪ Impact van certificering en CO2 allocatie: emissiefactoren, LCA ketenanalyse, etc. ▪ Financiering en stimulering (EU & NL): IPCEI, PCI, TEN-E, JTF, EIB, Horizon Europe, MOOI, DEI, MIEK, SDE++, etc	▪ Marktmodellen: bilaterale contracten, vrije handel, waterstofbeurs ▪ Internationale handelsstromen: verwachte vraag- en aanbodvolumes en transportstromen ▪ Importtarieven, trade agreements en handelsbeperkingen, WTO, etc.	▪ Samenwerking met omringende EU/niet-EU importlanden om corridors te ontwikkelen ▪ Concurrentie met omringende EU/niet-EU importlanden ▪ Geopolitieke aspecten: strategische voorraden, afhankelijkheid, politieke stabiliteit van exportlanden	▪ Ruimtegebruik van ketenelementen ▪ Veiligheid: brandbaarheid, zorgwekkende stoffen, risicocontouren, etc ▪ Milieu: stikstof, lekkage ▪ Maatschappelijke acceptatie ▪ MVO / samenhang met SDG's in exportlanden
Synthese				

TNO innovation for life

ACTUALITEITEN | TOUR DE TABLE

Zet teams op ‘together mode’



WEBSITE SHIPNL

www.nationaalwaterstofprogramma.nl

- www.nationaalwaterstofprogramma.nl -> CSWW -> CSWW thema's -> Import, doorvoer, export -> SHIPNL pagina

DEEP DIVE I: FIRST MOVER LANDEN: JAPAN, DUITSLAND EN… NEDERLAND?

Thomas Hajonides van der Meulen | TNO

1/3) LANDEN HEBBEN EIGEN REDENEN OM STRATEGISCH OVER WATERSTOF NA TE DENKEN: TWEE VOORBEELDEN

2/3) EN WAT GEBEURT ER IN NEDERLAND? VAN DENKEN IN 'KOSTEN' NAAR DENKEN IN 'PRIJS'

3/3) MOLECULEN IMPORT NAAR NL

Doel: Verruiming van de term waterstof (H_2 → H_2-derivatives MeOH, EtOH, NH_3, …)

Welke importpaden zijn er te bewandelen?

1/3) LANDEN HEBBEN EIGEN REDENEN OM STRATEGISCH OVER WATERSTOF NA TE DENKEN: TWEE VOORBEELDEN

GERMANY

- Front-runner in renewable energies strategy: "Energiewende" Renewable energy share in gross final energy consumption reached 19% in 2020.
- Global and European hydrogen market will emerge in 2030 and that carbon-free hydrogen will be traded.
- Coupling offshore wind energy with hydrogen production
- Elaborate funding for hydrogen based fuels and advanced biofuels.
- Continue with existing Energy Efficiency Incentive Programme.
- Extensive governance framework
- Committed public investments: $10.4 billion. Provides probably more than a quarter of global state aid under a national hydrogen strategy.

JAPAN

- Severe lack of hydrocarbon resources
- Cheap import routes + renewables + intern and extern supply chain
- Used as fuel for energy areas where electrification is difficult
- Commercialize hydrogen power generation

Voor meer details: zie bijlage

1/3) LANDEN HEBBEN EIGEN REDENEN OM STRATEGISCH OVER WATERSTOF NA TE DENKEN: TWEE VOORBEELDEN

Een voorbeeld van Duits onderzoek in Marokko

Fraunhofer ISI

STUDY ON THE OPPORTUNITIES OF "POWER-TO-X" IN MOROCCO

10 HYPOTHESES FOR DISCUSSION

On the basis of the analysis of the 10 hypotheses the following **recommendations for short- and medium term R&D on PtX in Morocco** can be derived:

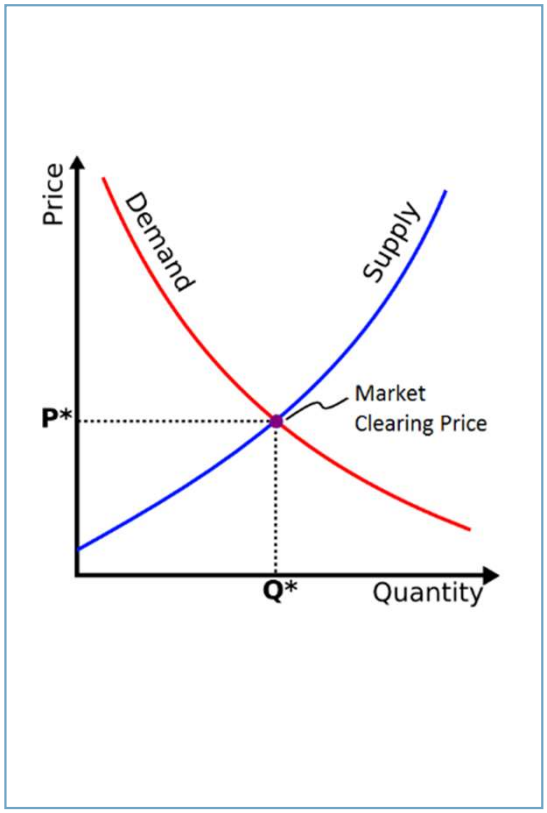
1. Establishment of a detailed 2050 energy and climate strategy and of 2050 energy and climate targets for Morocco.
2. Elaboration of a roadmap for hydrogen and derived PtX products for Morocco.
3. Elaboration of an infrastructure roadmap for hydrogen and derived PtX products for Morocco.
4. Development of sustainability criteria in the frame of the hydrogen/PtX roadmap.
5. Investigation of governance structures for a Moroccan hydrogen and ammonia industry.
6. Investigation of electricity market design to support a Moroccan hydrogen and ammonia industry.
7. Development of technological R&D and demonstration plants of a reasonable size of several MWs which can enhance experience with technologies. Development of a market introduction scheme.

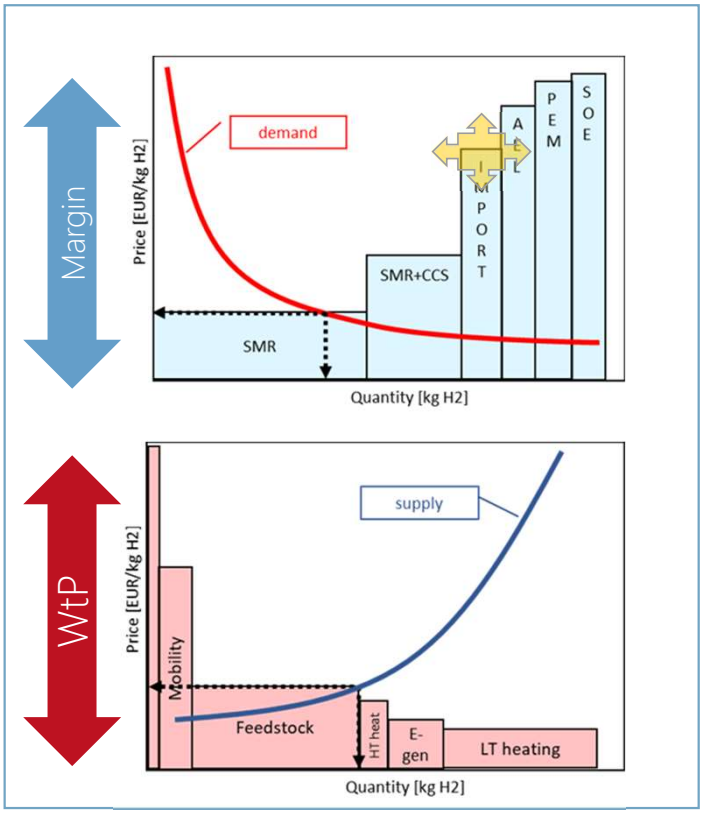
The **ten hypotheses formulated** and discussed in Chapter 5 are the following:

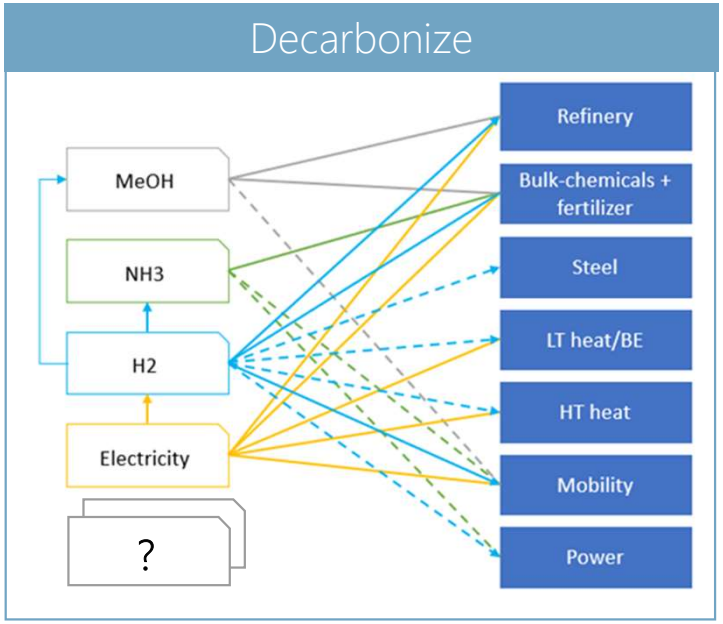
1. Hypothesis 1: The demand for PtX will be driven by the requirements on developed countries to reach a reduction of 95% in view of contributing to the 1.5°C target of the Paris Agreement.
2. Hypothesis 2: If the requirement would only be 80% reduction in GHG (which is possibly compatible with a 2°C scenario) there would be very limited need in developed countries for PtX.
3. Hypothesis 3: Developing countries have lower GHG reduction requirements by 2050, hence less pressure to introduce PtX for own purposes.
4. Hypothesis 4: There is no need for PtX from the pure requirement of a 100% RES share in the power sector. This concerns both Morocco and for example European countries, as long as the power systems are optimised (grid expansions, market arrangements,...).
5. Hypothesis 5: Morocco can capture a non-negligible share in the world-wide demand for PtX.
6. Hypothesis 6: Power exports to Europe is not a strong competitor for PtX exports.
7. Hypothesis 7: PtX products may under favourable conditions become economic compared to fossil competitors beyond 2030.
8. Hypothesis 8: The production of synthetic ammonia offers - under favourable conditions - economic opportunities to Morocco as a producer of green ammonia for own purposes and for export.
9. Hypothesis 9: RES development should be accompanied by a hierarchy principle minimising necessary expansion, even with further falling cost, to minimise broader environmental impacts.
10. Hypothesis 10: Sustainability criteria play an important role for PtX in Morocco.

2/3) EN WAT GEBEURT ER IN NEDERLAND? VAN KOSTEN NAAR PRIJS

HyDelta (2022): Untangling the dynamics of a future hydrogen market





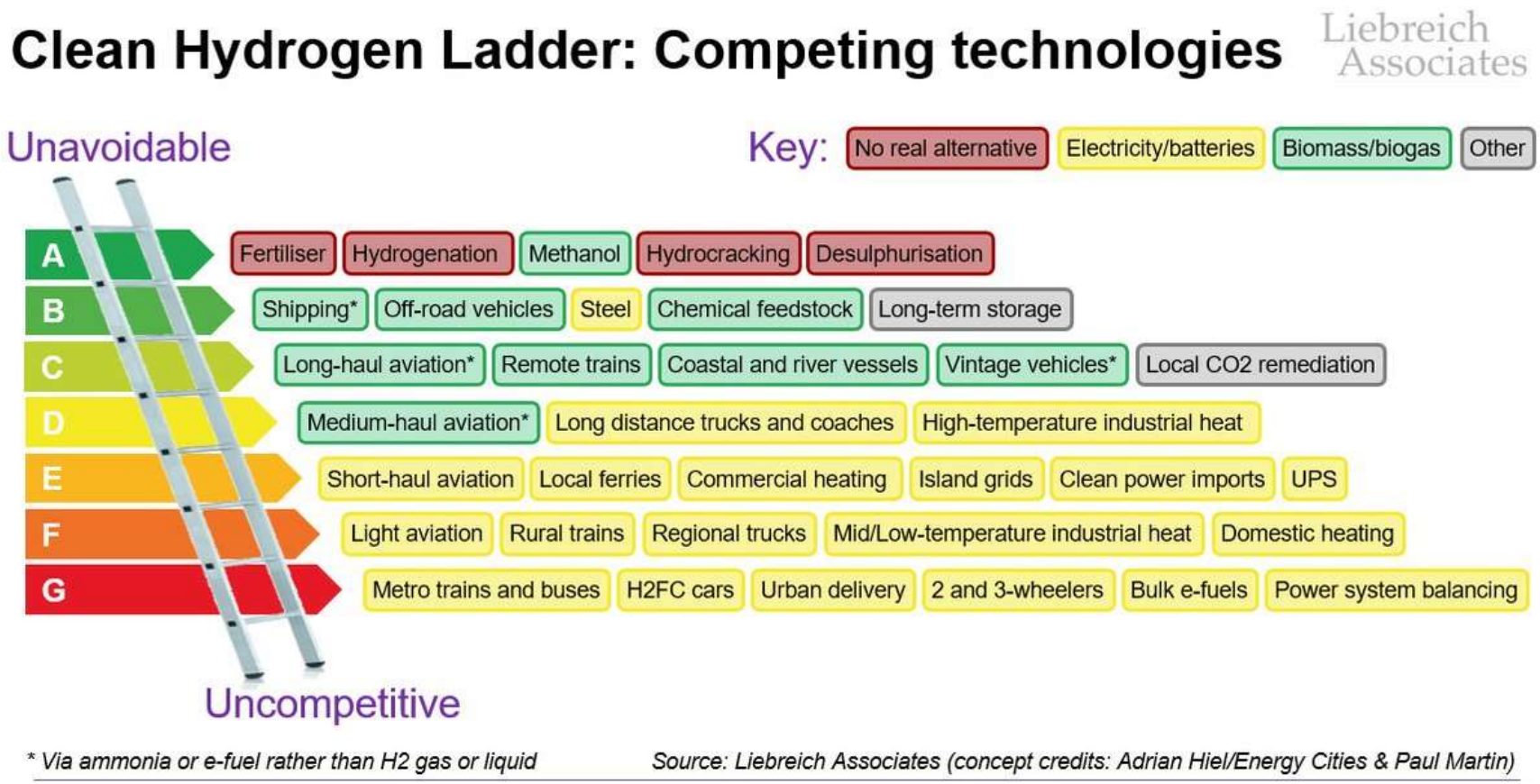


Business as usual + accept CO_2 costs

Relocate

2/3) EN WAT GEBEURT ER IN NEDERLAND? VAN KOSTEN NAAR PRIJS

Welke toepassingen van waterstofgas zullen opschalen in Nederland?



2/3) EN WAT GEBEURT ER IN NEDERLAND? VAN KOSTEN NAAR PRIJS

Wat zijn jullie ervaringen en perspectieven…?

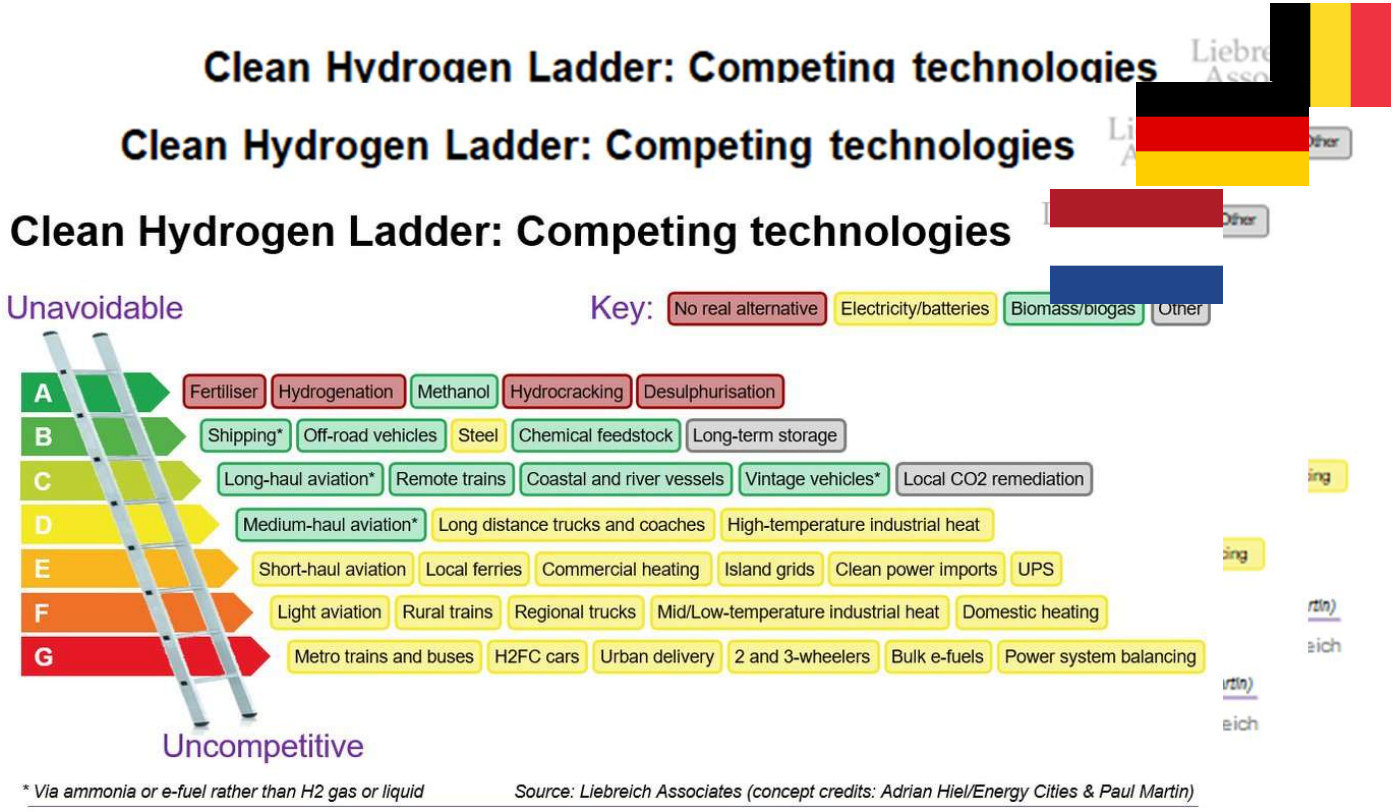
Over (import) *kosten* is relatief veel bekend…

- Wat is jullie ervaring met gesprekken over toekomstige *prijzen*?*

- En hoeveel inzicht in prijs (t.o.v. kosten) is nodig voor het nemen van FIDs per partij in de importketen?

* NB: zie huisregels t.a.v. mededinging. Drijfveren en barrières; waar loop je tegenaan.

3/3) MOLECULEN IMPORT NAAR NL



3/3) MOLECULEN IMPORT NAAR NL

- **Waarom?** — **Eigen gebruik, EU handel, mondiale handel**
- **Welke producten?** — **Synthetische en biogene waterstof, -ammoniak, -methanol, -ethanol, -diesel, -kerosine, …**
- **Wanneer?** — **2022 – 2050+**
- **Hoeveel?** — **Gestuurd door vrijwillige vraag, opgelegde vraag (regelgeving) of aanbod?**
- **Hoe? Waar?** — **Schip, pijpleiding, (truck, trein)**

Gegeven de enorme verduurzamingsopgave en ons kritieke tijdspad naar 2030 en 2050:

Wat moeten we doen?

DISCUSSIE: ROUTEKAART IMPORT NATIONAAL WATERSTOF PROGRAMMA

Han Feenstra | Ministerie van Economische Zaken en Klimaat

TNO innovation for life

Import en export | Routekaart

Bijdrage missie: zorgen voor voldoende aanbod van koolstofarme waterstof in NL, bijdragen aan mondiale inzet op internationale hernieuwbare energieketens, borgen van Nederlandse positie als energiehub in NW Europa

2022-2025	2025-2030	Na 2030
Doelen / mijlpalen: 1. Markt voor koolstofarme H_2 gecreëerd 2. Infrastructuur voor import gereedgemaakt 3. Eerste importen aangeland	Doelen / mijlpalen: 1. Import onderdeel van EU markt 2. NL onderdeel van belangrijke ketens 3. Grensoverschrijdende infra ontwikkeld	Vergezicht • Koolstofarme waterstof en afgeleide verbindingen worden mondiaal toegepast met duurzame lokale impact • Mondiale ketens gerealiseerd voor koolstofarme waterstof en afgeleide verbindingen • Geografische verschuiving van industrie en bijbehorende energie- en grondstofketens • Gestandaardiseerde technologieën voor transport en opslag • Representatief aandeel Nederlandse bedrijven in internationale ketens
Acties: 1. Internationale certificering 2. Import onderdeel maken van infra planning (MIEK/PIDI) 3. Faciliteren van eerste projecten	Acties: 1. Inzet op EU beleid en kaders 2. Actieve rol in opbouwen van ketens, IMVO conform 3. Bilaterale en EU infra-afspraken	
Randvoorwaarden: 1. Helder EU kader, certif. schema's, faciliterende rol overheid 2. Stimulering (H2Global, innovatie, verplichting, IPCEI, BHOS) 3. Helderheid over marktordening	Randvoorwaarden: 1. Heldere wetgevende kaders 2. Nationale instrumenten en multilaterale kaders 3. Helderheid over marktordening	

Import en export | Routekaart korte termijn overheid

SHIP sessie 18/5 & 15/6

Bijdrage missie: zorgen voor voldoende aanbod van koolstofarme waterstof in NL, bijdragen aan mondiale inzet op internationale hernieuwbare energieketens, borgen van Nederlandse positie als energiehub in NW Europa

2022-2023	2024	2025
Doelen / mijlpalen: • Technisch-economisch • Beleid • Markt • Internationaal • Omgeving	Doelen / mijlpalen: • Technisch-economisch • Beleid • Markt • Internationaal • Omgeving	Doelen / mijlpalen: • Technisch-economisch • Beleid • Markt • Internationaal • Omgeving
Acties:	Acties:	Acties:
Randvoorwaarden	Randvoorwaarden:	Randvoorwaarden:

Import en export | Routekaart korte termijn bedrijfsleven

Bijdrage missie: zorgen voor voldoende aanbod van koolstofarme waterstof in NL, bijdragen aan mondiale inzet op internationale hernieuwbare energieketens, borgen van Nederlandse positie als energiehub in NW Europa

2022-2023	2024	2025
Doelen / mijlpalen: • Technisch-economisch • Beleid • Markt • Internationaal • Omgeving	Doelen / mijlpalen: • Technisch-economisch • Beleid • Markt • Internationaal • Omgeving	Doelen / mijlpalen: • Technisch-economisch • Beleid • Markt • Internationaal • Omgeving
Acties:	Acties:	Acties:
Randvoorwaarden	Randvoorwaarden:	Randvoorwaarden:

PLANNING TOTSTANDKOMING VAN DE ROUTEKAART

Datum	Actie
Woensdag 18 mei	Korte bespreking concept door EZK en ophalen eerste commentaar.
Maandag 23 mei	Deadline suggesties voor hoofdlijnen en tekstblokken met korte toelichting (direct schriftelijk sturen aan TNO (Monique) en EZK (Han)).
1e helft juni	Opstellen concept versie algehele routekaart in samenwerking met de trekkers van de andere werkgroepen.
15 juni F2F Meeting	Gezamenlijke review tijdens SHIP>NL overleg bij Min.EZK in Den Haag Uitwerking detailplan Routekaart 2022-2025
September	Presentatie routekaart aan de minister en Tweede Kamer.

VOORLOPIG PROGRAMMA KENNISSESSIE 15 JUNI A.S.

Face-to-Face bijeenkomst bij Min. EZK in Den Haag

15 juni	Onderwerp	Organisatie
	Routekaart Import | NWP deel II	Min. EZK

TNO innovation for life

HARTELIJK DANK VOOR UW AANDACHT

Vragen? Neem gerust contact met mij op:

Monique Rijkers

Monique.Rijkers@tno.nl

+31 6 23 34 65 16

DEEP DIVE I: BIJLAGE

Thomas Hajonides van der Meulen | TNO

TNO innovation for life

GERMANY

Since 2010, Germany is making its energy system more efficient, supplied mainly by renewable energy sources and hydrogen. The country has adopted a strategy for an energy pathway to 2050..

2021 — 2030 — 2050

NOW

- Front-runner in renewable energies strategy: energiewende.
- Conventional energy sources still account for two thirds of the electricity.
- Renewable energies have undergone rapid growth in Germany. Their share in gross final energy consumption reached 19% in 2020.

SHORT-TERM GOALS

- The Federal Government will make a binding reduction of -55% of GHG.
- Global and European hydrogen market will emerge and that carbon-free hydrogen will be traded.

LONG-TERM GOALS

- Full carbon neutrality on GHG emissions.

TNO innovation for life

GERMANY – NATIONAL HYDROGEN STRATEGY ACTIVE PLAN

01 HYDROGEN PRODUCTION

1. Better framework for the efficient use of electricity from renewables and a fair design of the energy price components induced by the state.
2. Reduce burden on the grids, lowering prices.
3. Industrial funding investment in electrolyzers.
4. Evaluate efficacy of investments on coupling offshore wind energy with hydrogen production

02 TRANSPORT

1. Stimulate use of green hydrogen as fuel – Hydrogen to fuel.
2. Stimulate use of Fuel Cells vehicles (€2.1 billion);
3. Elaborate funding for hydrogen based fuels and advanced biofuels.
4. Elaborate funding for refueling stations
5. Support the Clean Vehicles Directive and carbon based tolls.
6. International standarlization.

03 INDUSTRIAL SECTOR

1. Funds and Programs to compensate the costs of hydrogen as feedstock and fuel..
2. Supporting industrial electrolyzes mostly for process emissions based on the difference between the costs and the ETS prices for C&O.
3. Stimulate market demand for low emission products.
4. Promote discussion with stakeholders to develop a long-term strategy

04 HEAT

1. Continue with existing Energy Efficiency Incentive Programme.
2. Discovering funding alternatives for hydrogen combined power and heat

05 INFRASTRUCTURE / SUPPY

1. Promote dialogue and regulatory basis for re-use or re-dedication of pipelines and natural gas structures.
2. Continued effort to improve infrastructure – energiewende.
3. Special attention to hydrogen refueling stations and waterways

06 RESEARCH AND EDUCATION

1. Joint Hydrogen Roadmap with scientists and business.
2. Setting up demonstration projects.
3. New research fund in different areas: from regulations to market entry.
4. Funding programme to support hybrid electric aviation.
5. Hydrogen related research for green shipping fleets.
6. Foster education and vocational training nationally and internationally.

07 EU LEVEL

1. Set standards, regulations and codes for the international market.
2. Joint research, development and demonstration of green hydrogen.
3. Establishing a EU hydrogen Strategy.
4. The establishment of a European hydrogen company.

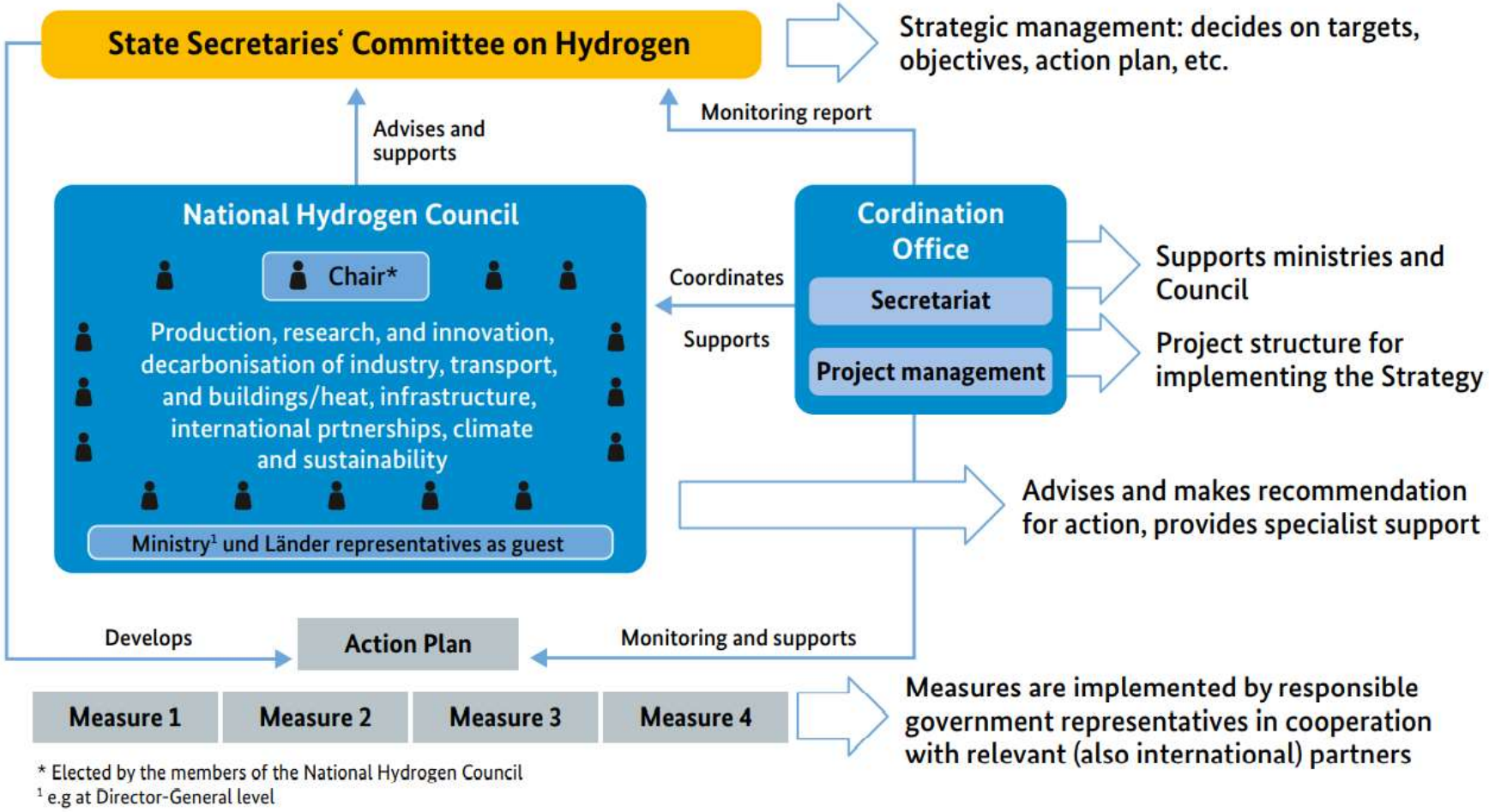
08 INTERNATIONAL LEVEL

1. Integration of hydrogen into existing energy partnerships
2. Establishment of new partnerships with strategic countries.
3. Building a hydrogen Allience.
4. Ally with international research organizations to set best route/supply chain model.
5. Pilot projects in partner countries.
6. Influence fossil fuel exporters towards energy transition including hydrogen

Extensive governance framework

GERMANY

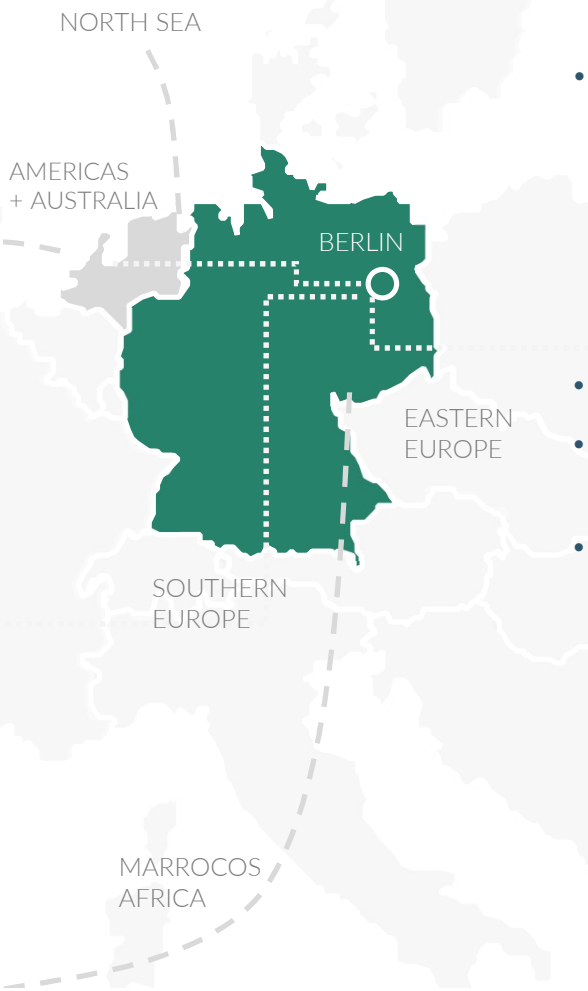
HYDROGEN GOVERNANCE



* Elected by the members of the National Hydrogen Council
[1] e.g at Director-General level

TNO innovation for life

GERMANY TODAY



- Germany entered into an alliance with Morocco for the development of the Power-to-X. The two sides are planning to establish some **100 megawatts in electrolysis** capacity.
- Germany has shortlisted **62 hydrogen production** and infrastructure projects as Important Projects of Common European Interest (IPCEI)
  - 50 projects including **electrolyzers** with a combined capacity of over 2 GW and **pipelines** with a length of 1,700 km
  - Further 12 projects in the **mobility sector** for development and production of fuel cell systems and vehicles as well as refueling infrastructure.
- Germany is preparing a **loan for Ukraine's** hydrogen energy project development.
- Germany will support green hydrogen projects in **other countries** with up to 350 million euros by 2024 and has published a directive with the relevant guidelines, the economy ministry said in a press release.
- **Port of Antwerp, Port of Zeebrugge** and **Chile** sign Memorandum of Understanding (MoU) to foster hydrogen production to Germany.

CARRIERS	AMMONIA, MCH, LH_2 (DEMO PHASE)
PARTNER COUNTRIES	NORTHERN AFRICA, LATIN AMERICA, AUSTRALIA, EASTERN EUROPE, SOURTHERN EUROPE.
TRANSPORT	SHIPPING + PIPELINE
STRENGTH	PIPELINE NETWORK, ENERGIEWENDE
COMPANIES	SHELL, ARCELORMITTAL, EWE, SWB (UTILITIES), GASUNIE AND TENNET.

TNO innovation for life

GERMANY OUTLOOK

PUBLIC INVESTMENTS

Germany, by funding its hydrogen strategy with significantly over $10 billion (already committing $10.4 billion under the Package for the Future alone), provides probably more than a quarter of global state aid under a national hydrogen strategy.

2006

+ € 0,7 BI
UNDER NIP → HYDROGEN AND FUEL CELLS

2016

2020

+ € 0,5 BI
INITIAL PRACTICAL RESEARCH

+ € 0,6 BI
LAB TO MARKET SOLUTIONS

+ € 1 BI
PROCESS DECARBONIZATION

2023

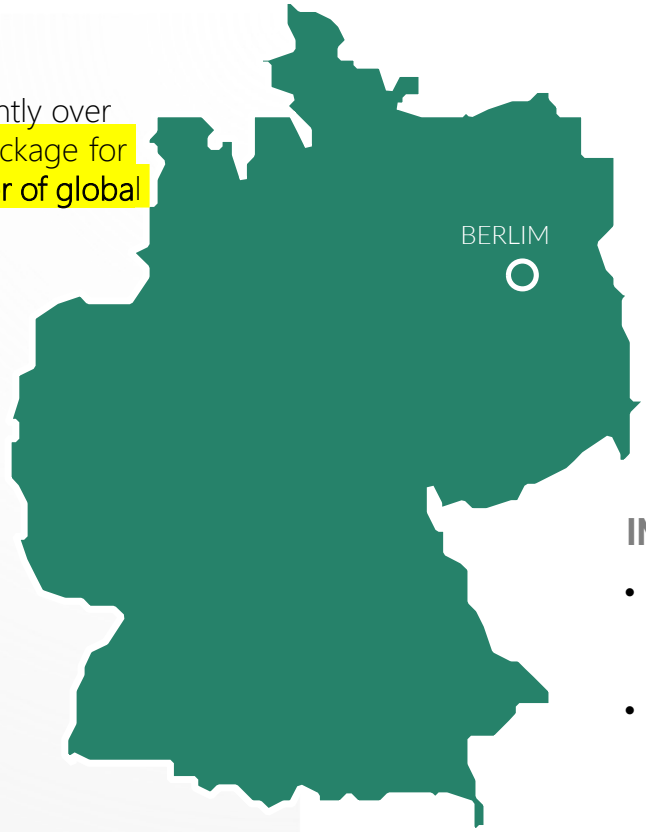
+ € 1,4 BI
UNDER NIP → HYDROGEN AND FUEL CELLS

2026

+ € 7 BI
BASE MATERIAL INDUSTRY ROLLOUT

+ € 2 BI
INTERNATIONAL PARTNERSHIP

+1/4
OF WORLDS INVESTMENT IN HYDROGEN COMES FROM GERMANY



GERMAN LEADERSHIP

- As a country with an advanced hydrogen research landscape, Germany seeks to become a **leader** on hydrogen.
- Germany aims to be a **exporter** of green hydrogen technologies and **importer** of energy.

INCREASING DEMAND FOR HYDROGEN

- Around **90 to 110 TWh** of hydrogen will be needed by 2030 and between **110-380 TWh** by 2050..
- Germany plans to establish up **to 14 TWh of green hydrogen** including the offshore and onshore energy generation by 2030 and more **14 TWh** until 2050.
- Germany will continue to import much of its energy from abroad. We will foster and intensify international cooperation and partnerships on hydrogen.

TNO innovation for life

JAPAN

Japan is a highly industrialized country with a severe lack of hydrocarbon resources that sees multiple values in using hydrogen, including energy security, industrial competitiveness, and carbon emissions reduction.

2021

NOW

- Low self-sufficiency rate of 6-7%.
- 87% of oil based fuels from the Middle East.
- Heavily dependent on hydrocarbons shipped mainly from the Middle East and Australia, to meet its energy demand.

2030

SHORT-TERM GOALS

- Cut GHG emissions by 46% (up from 26%).
- To have the world's first full-scale hydrogen supply chain.
- 3 Mt H_2 domestic hydrogen market.
- 0.8 million fuel cell vehicles.
- 5 million residential fuel cells.
- Import of 300kton hydrogen
- Supply cost of about 0.23 €/Nm^3 (2.6 €/kg)

2050

LONG-TERM GOALS

- Net-zero in 2050
- Develop a 'hydrogen society'.
- 20 Mt H_2 domestic market
- Supply cost of about 0.15 €/Nm^3 (1.7 €/kg)

TNO innovation for life

JAPAN – HYDROGEN STRATEGY BUILDING BLOCKS

01 LOW-COST OF HYDROGEN

1. 2030: Hydrogen Price at 30 yen/Nm3
2. 2050: Hydrogen Price at 20 yen/Nm3
3. Cheap import routes + renewables + intern and extern supply chain.

02 INTERNATIONAL SUPPLY CHAIN

1. Developing carrier technologies:
2. Starting liquified hydrogen supply chain by 2030;
3. Demos for organic hydride supply chain in 2025;
4. New methanation carbon free technologies.

03 RENEWABLE ENERGY EXPANSION

1. Expanding use of hydrogen from RE
2. New power-to-gas technologies to the market;
3. Reduce the unit cost for water electrolysis systems to 50,000 yen/kW;
4. Utilizing regional sources.

04 HYDROGEN POWER GENERATION

1. Commercialize hydrogen power generation.
2. 2030: cut the unit hydrogen power generation cost to 17 yen/kWh .
3. 2050: Make hydrogen power generation as cost competitive as LNG power generation

05 HYDROGEN FOR MOBILITY

Increase number of FC vehicles:

1. FC buses: 100 by 2020 and 1,200 by 2030.
2. FC forklifts:500 by 2020 and 10,000 by 2030.
3. Develop and commercialize FC trucks.
4. Promote fuel cells for small ships.

06 HYDROGEN FOR INDUSTRY

1. Used as fuel for energy areas where electrification is difficult.
2. Replace industrial-use hydrogen from fossil fuels.
3. Cutting carbon process emissions.

07 FUEL CELL TECHNOLOGIES

1. Lower the price to 800,000 yen for a PEFC and to 1 million yen for a SOFC by 2020 .
2. Building heating in high demand areas.
3. 2030: diffuse pure hydrogen fuel cell cogeneration systems using CO2-free hydrogen.

08 INNOVATIVE TECHNOLOGIES

Towards 2050: Necessary to develop innovative technologies for highly efficient as well as low-cost, highly efficient energy carriers and highly reliable, low-cost fuel cells.

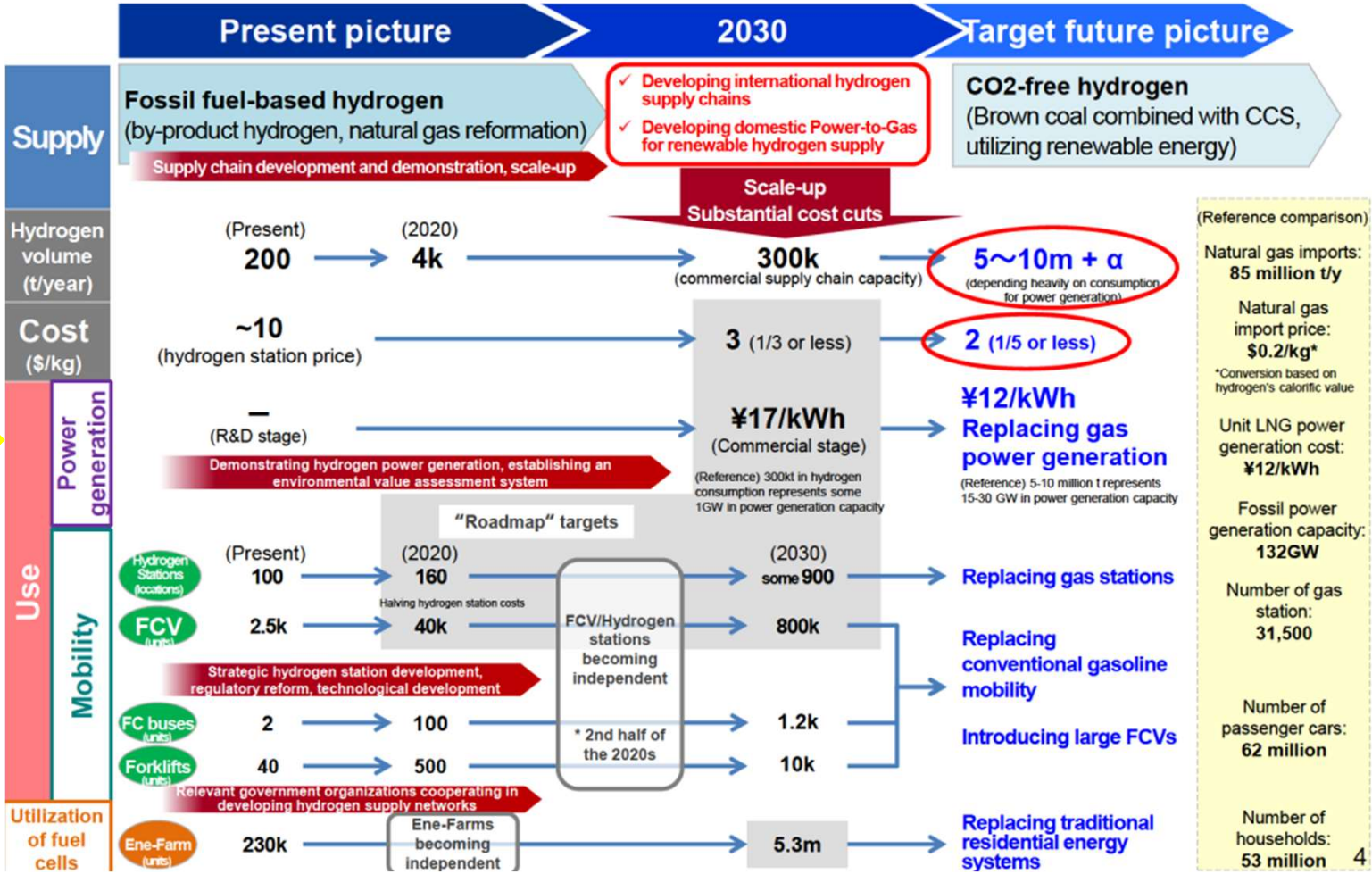
09 STANDARDIZATION

1. Japan will lead international standardization through international frameworks.
2. Japan will promote technological development and cooperation with relevant organizations.

JAPAN

SCENARIO FOR BASIC HYDROGEN STRATEGY

Strong focus G2P



TNO innovation for life

JAPAN TODAY

- Japan has the **largest fleet of hydrogen refuelling stations** in the world, with over 130 stations across the nation.
- First **liquefied H_2** vessel in 2019 and first liquefied H2 terminal in 2020.
- 2020: 10MW alkaline **electrolyzer (FH2R)** in operation at Fukushima Hydrogen Energy Research Field
- 2020: Japan received the world's first shipment of fossil fuel–based ammonia from **Saudi Arabia**.
- 2020: Demo shipping natural gas–based hydrogen from **Brunei to Japan**, as **LOHC** (MCH).
- 2021: Fuel-cell hydrogen transport during Tokyo **Olympics**
- 2022 first shipment of **Australian** lignite-based liquefied hydrogen to Japan led by a consortium including Japan's J-Power and Kawasaki Heavy Industries, along with Shell, AGL and with the support of the Japanese, Australian and Victorian governments.
- Kawasaki: 2 commercial-scale ships to import 225kt by 2030.

CARRIERS	ALL BUT FOCUS ON: AMMONIA, MCH, LH_2
PARTNER COUNTRIES	AUSTRALIA, MIDDLE-EAST, SOUTHEST ASIA
TRANSPORT	SHIPPING
STRENGTH	FUEL CELL, SHIPPING TECHNOLOGIES.
COMPANIES	J-POWER, KAWASAKI, SHELL, AGL, MITSUBISH.

JAPAN OUTLOOK

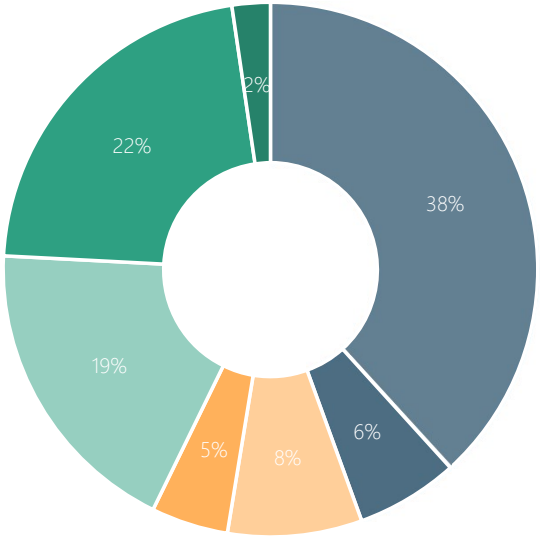
PUBLIC INVESTMENTS OF:

$ 0,65 BI

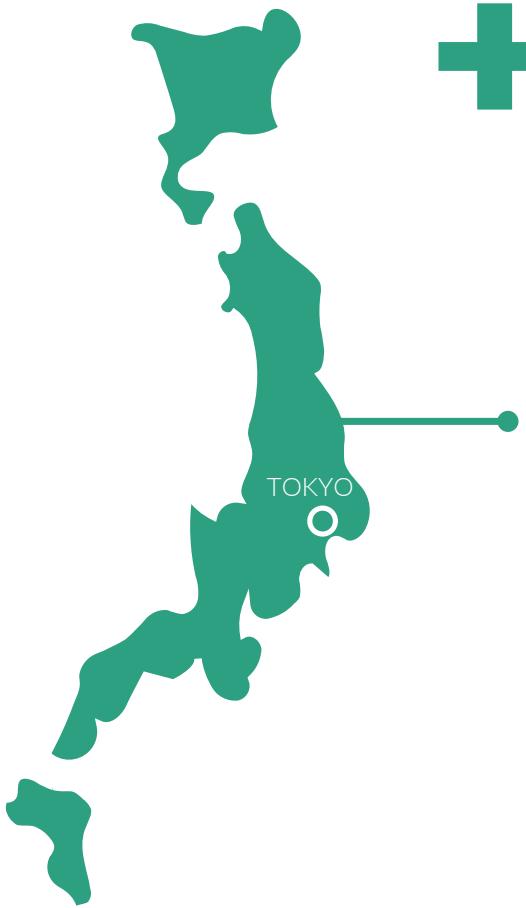
OF INVESTMENTS IN THE **2020** FISCAL YEAR

$ 2,7 BI

FOR **FUTURE** PROJECTS ON HYDROGEN SUPPLY CHAIN



- Clean energy vehicles
- Residential fuel cells
- Innovative fuel cell R&D
- Supply infrastructure R&D
- FCV refueling stations
- Development of H2 abroad
- Production, storage, and usage



PUBLIC-PRIVATE PARTNERSHIPs

- Carbon Neutral Port initiative → decarbonize port operations
- Public-Private Fuel Ammonia Promotion Council → expanded use of ammonia.
- + leading energy companies, automakers, heavy industry companies, and financial entities

5 POLICY TOOLS FOR HYDROGEN

1. GRANT FUNDING
2. TAX INCENTIVE
3. GUIDANCE POLICY IN FINANCES
4. REGULATORY REFORM
5. INTERNATIONAL COLABORATION

TNO innovation for life