Wind meets Gas 2022

Annemiek Asschert & Dennie Kleijweg

ebn Energising the transition

6 October 2022

Introduction EBN

- Dutch State owned company, fully owned by the Ministry of Economic Affairs and Climate
- Responsible for implementing parts of the Dutch energy and climate policy
- Historically involved in the whole gas production value chain (production, transport, commercial)
- Since 2016 a new strategy aimed at decarbonising the gas value chain

Our Dutch Gas

We make the best use of Dutch energy resources and see gas as an essential aspect on the road to making the gas value chain sustainable.

Return to Nature

We are taking a leading role in the efforts to address the decommissioning challenge and are making a contribution to the development of energy and CO2 storage.

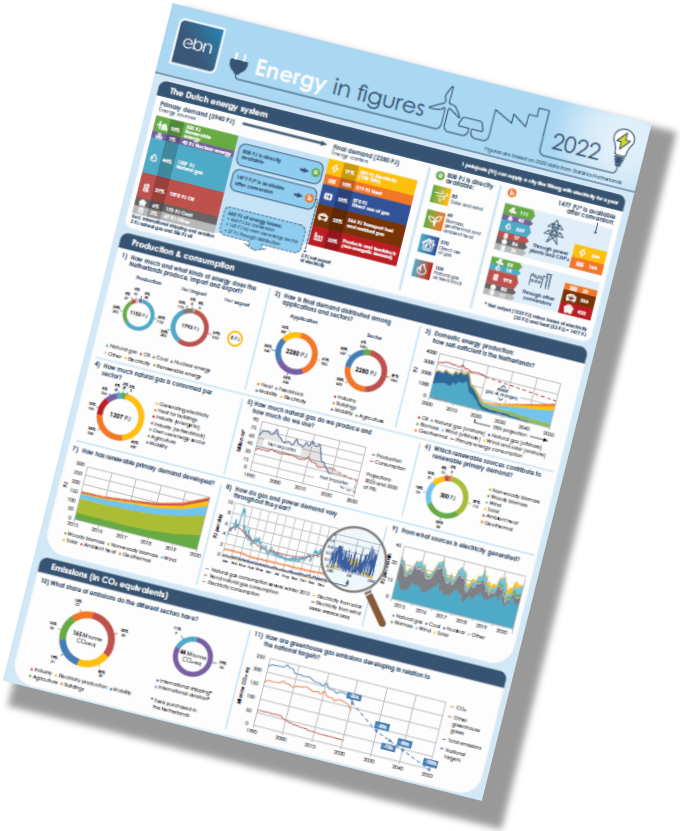
New Energy

We are helping to accelerate the development of (ultra-deep) geothermal energy and the exploration of other alternatives and sustainable energy sources.

Energy in figures

An annual EBN product

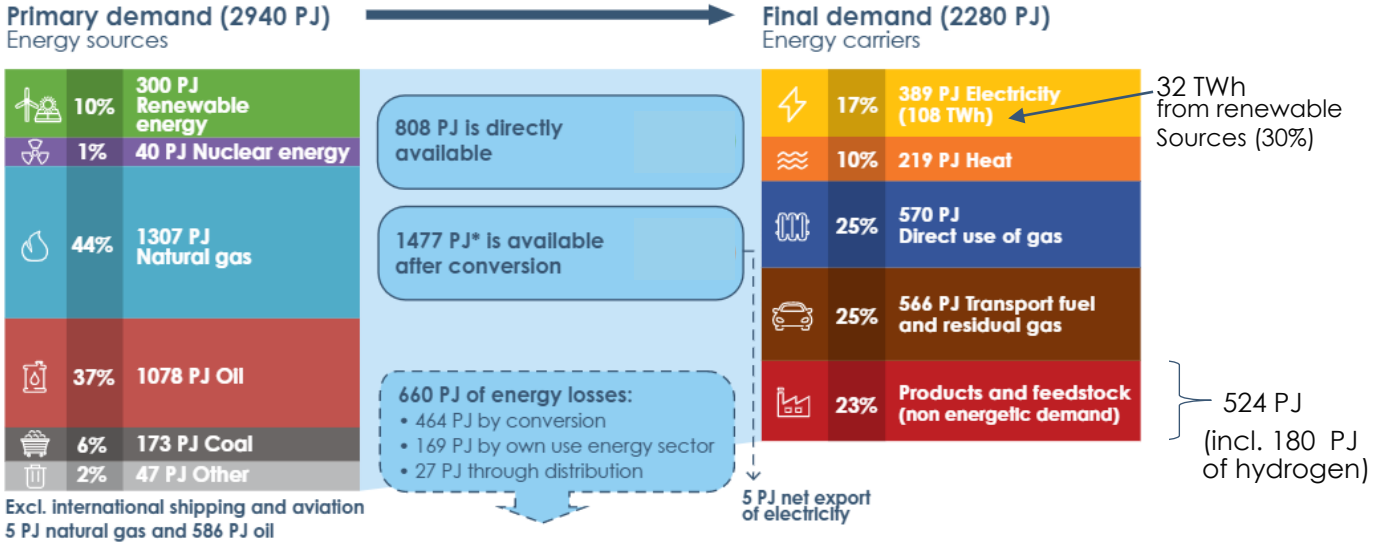
Based on objective facts and figures, obtained from CBS and the national emissions authority (NEA)



Ref: www.energieinnederland.nl

From primary energy use to final demand

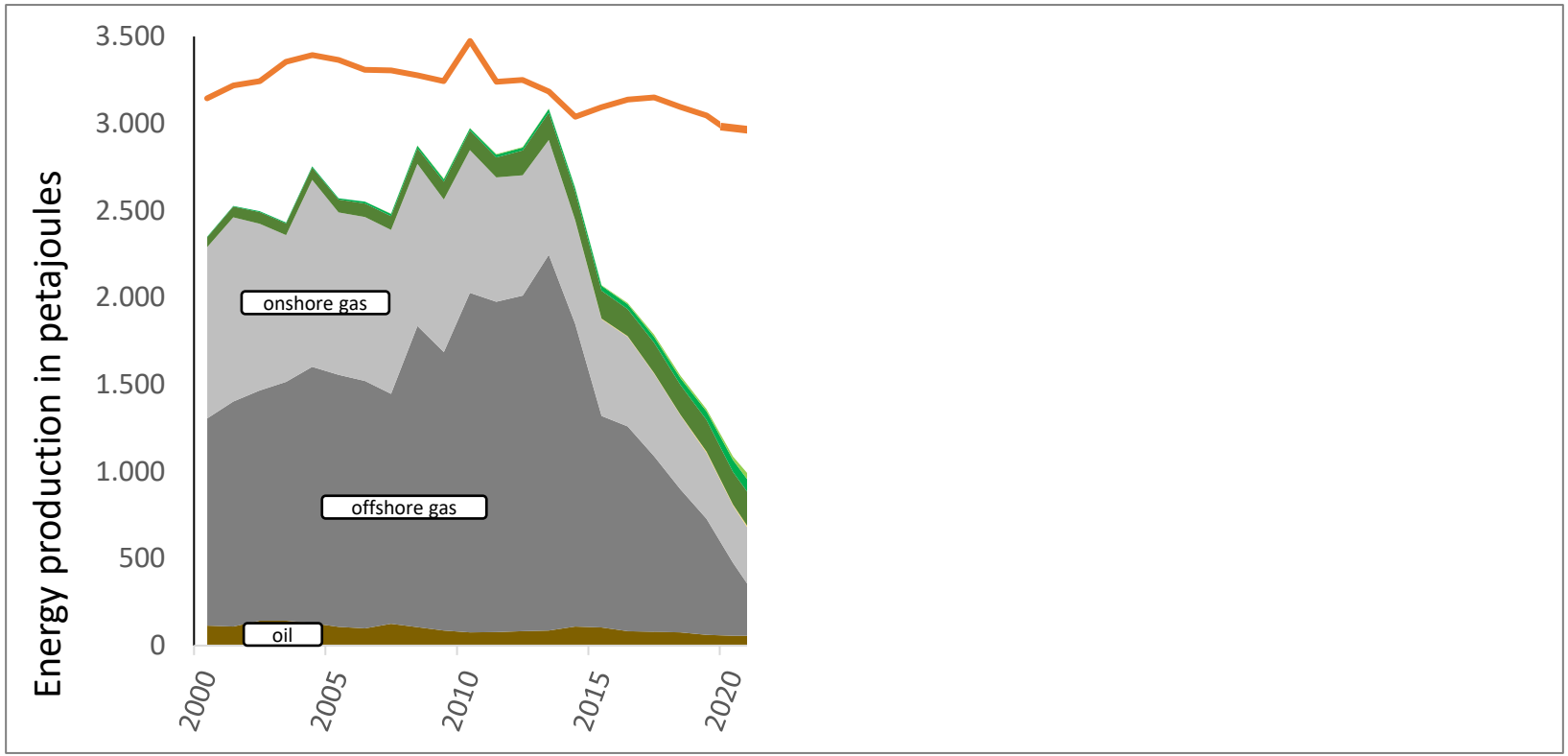
Simplified version - energy **sources** vs. energy **carriers**



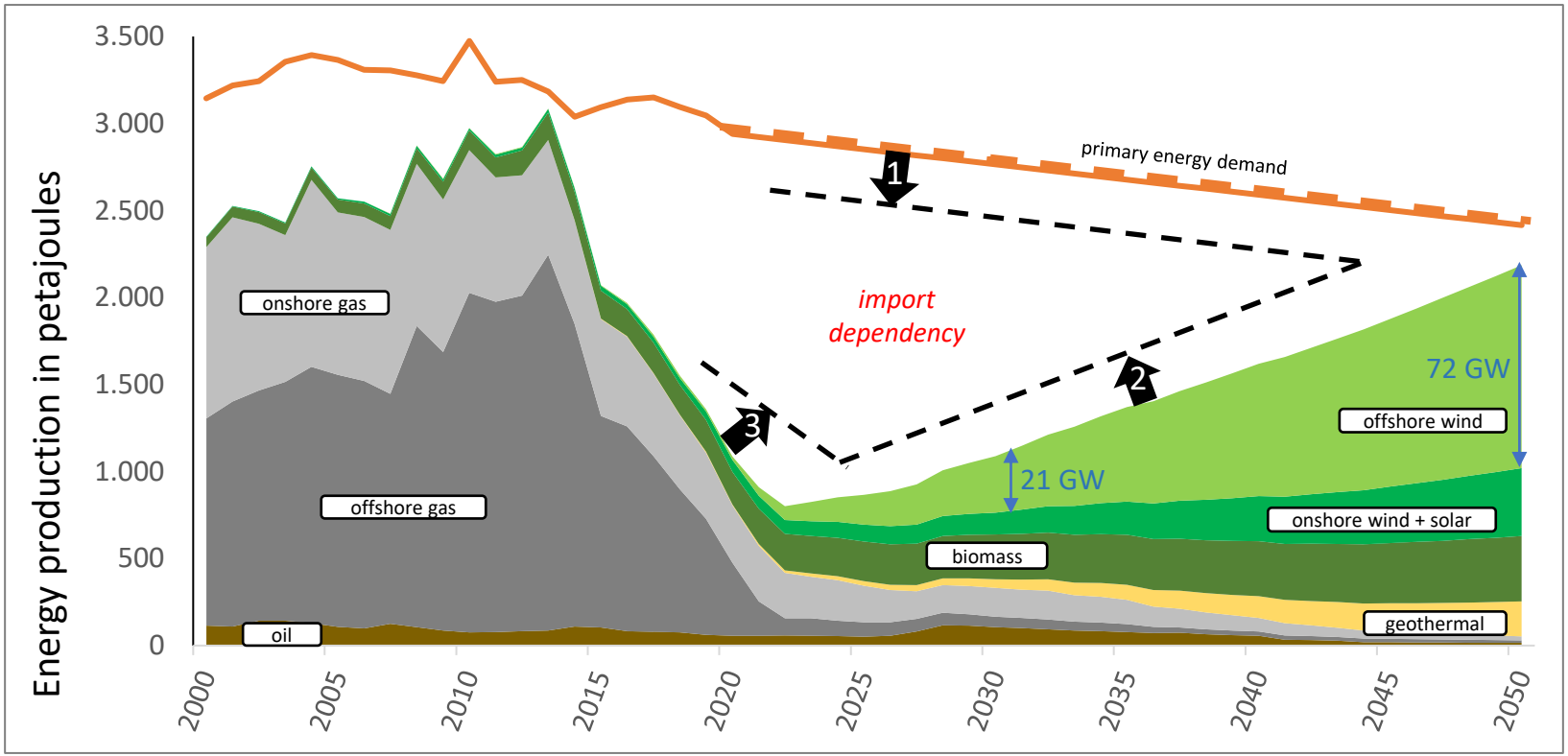
EBN, 2022 – www.energieinnederland.nl

The share of renewables is rapidly growing (in 2022 about 13%)

Development of Dutch domestic energy production



How to decrease import dependency?

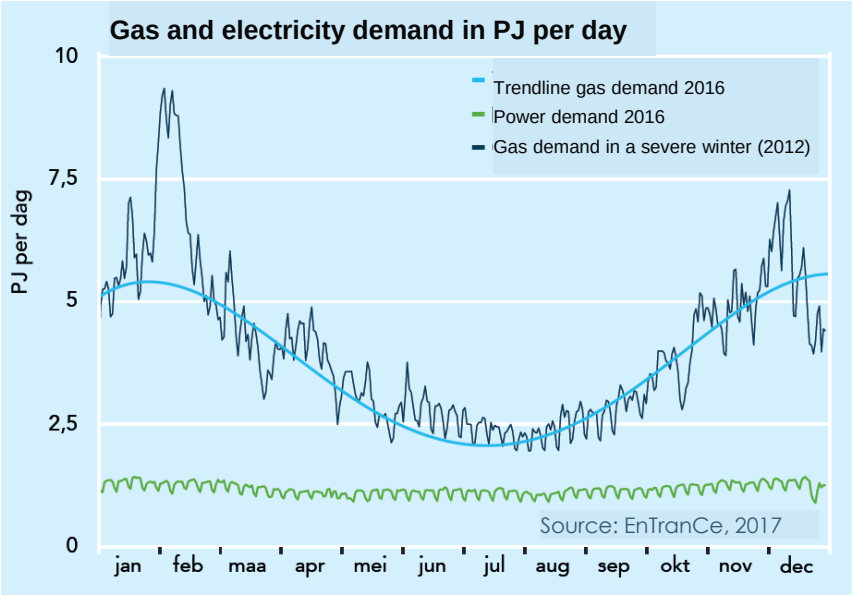


The special system role of natural gas

in dealing with fluctuations in heat demand and power demand

System advantages of natural gas:

1. The large **seasonal variation** in demand is met by gas storage
2. **Quick response** during sudden cold spells in the winter
3. **Short-term fluctuation** in power demand is solved by scaling up or down gas-fired power plants
4. Gas-fired power plants are also used to compensate **variation on the supply side** of electricity (wind and solar)




H
CO
2

Hydrogen colour pallet

	GREY HYDROGEN	BLUE HYDROGEN	GREEN HYDROGEN	PINK HYDROGEN
Process	Reforming or gasification	Reforming or gasification with carbon capture	Electrolysis	Electrolysis
Energy source	Fossil fuels 	Fossil fuels 	Renewable electricity 	Nuclear power 
Estimated emissions from the production process[a]	Reforming: 9 – 11[b] Gasification: 18 – 20	0.18 – 6.1[c]	0	0

Note: a) $CO_{2\text{-eq}}$/kg = carbon dioxide equivalent per kilogramme; b) For grey hydrogen, 2 kg $CO_{2\text{-eq}}$/kg assumed for methane leakage from the steam methane reforming process. c) Emissions for blue hydrogen assume a range of 99.8% and 68% capture rate.

Current annual production of grey H_2:

- Europe: **8 Mt/a**
- Netherlands: **1.5 Mt/a**

Roles for hydrogen

Role of hydrogen is needed to balance the electricity system

Is hydrogen going to take over the system role that natural gas had until today?

Advantages of hydrogen:

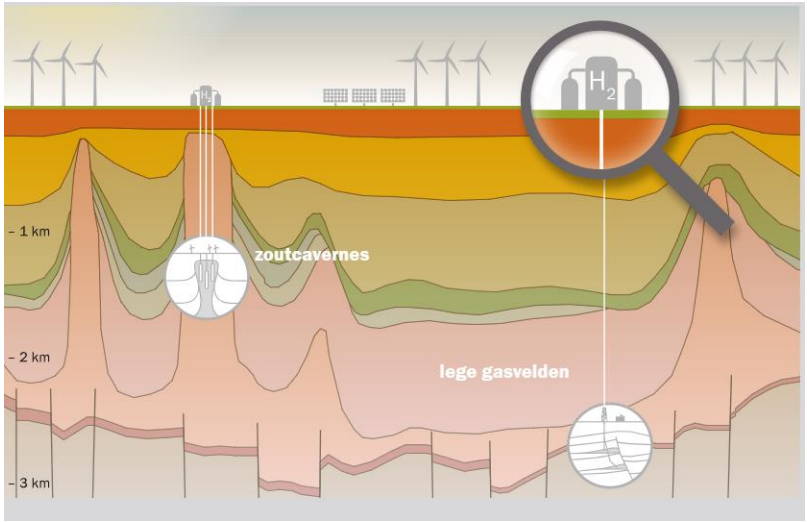
1. Large-scale **energy storage** can be done with hydrogen

2. **Transport** of wind-energy over larger distances from the windfarms to the coast could be done via hydrogen; this requires offshore conversion

3. Hydrogen or a hydrogen-carrier (e.g. ammonia) can be shipped (large energy density) **internationally**

Or summarized: **the mismatches both in space and time between the production and consumption of renewable energy can be dealt with using hydrogen**

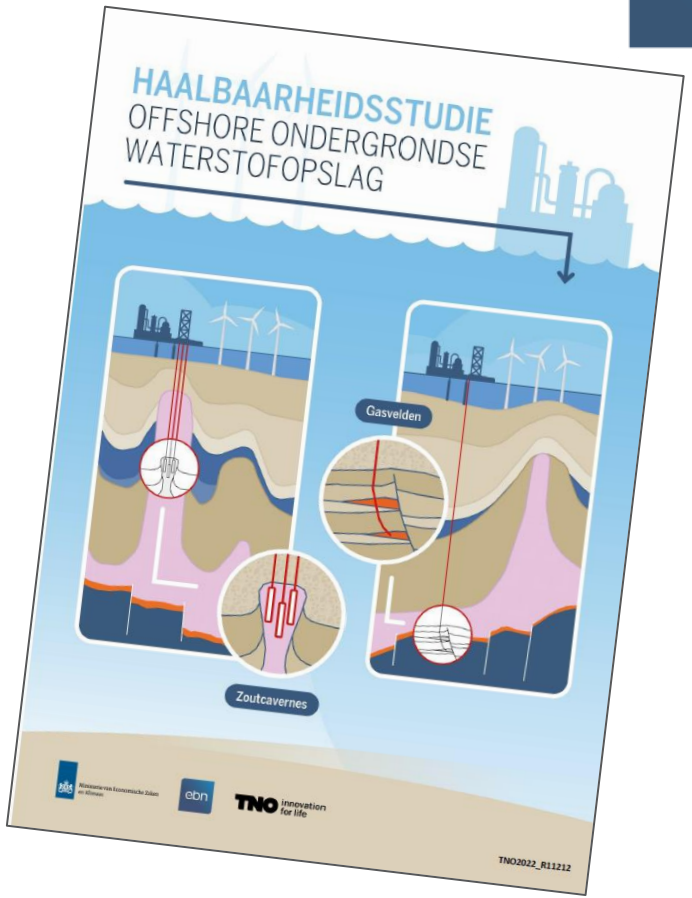
Subsurface hydrogen storage



Source: TNO & EBN, 2020

Feasibility study offshore UHS

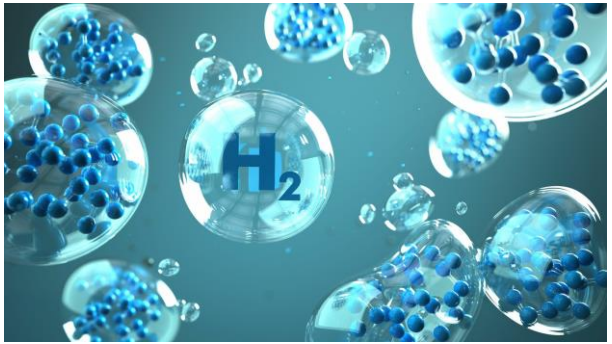
- Concepts and technical feasibility of offshore UHS
- Which infrastructure can be re-used for UHS
- Timing for demand UHS and available storages
- Main criteria for offshore vs onshore UHS considerations
- Barriers and synergies with other offshore activities



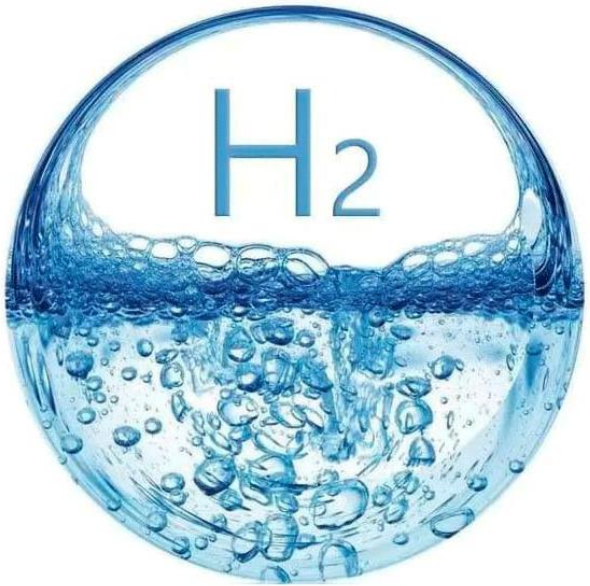
EBN & TNO (2022)

Hydrogen statements

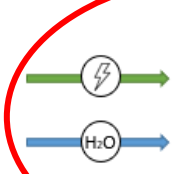
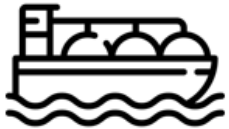
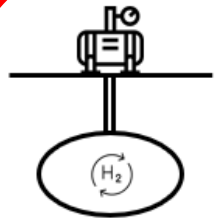
- All parts in the hydrogen chain are fully integrated and the development of the value chain requires an integral vision accordingly
- Blue hydrogen will play a key role in the rapid development of the hydrogen value chain
- Future security of supply requires priority in development of subsurface hydrogen storage
- The role of public parties participating in the value chain will have significant advantages
- Re-use of existing infrastructure will support fast and cost-effective development of the value chain
- Spatial planning of the energy system requires an integral vision



Hydrogen dilemma's

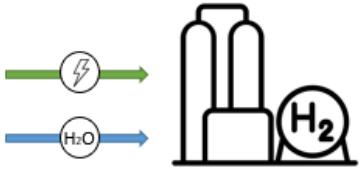


Hydrogen value chain

Production	Transport	Storage	Utilization
 Electrolysis	 Pipeline	 Tanks	 (Heavy) transport
 Methane reforming (SMR or ATR)	 Ship (several options)	 Underground	 Industry

Value chain

Production

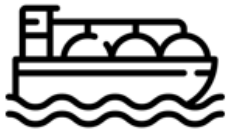


Electrolysis

Methane reforming
(SMR or ATR)

Transport

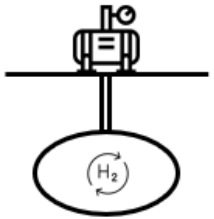
Pipeline



Ship
(several options)

Storage

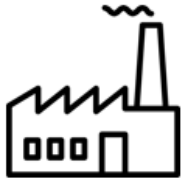
Tanks



Underground

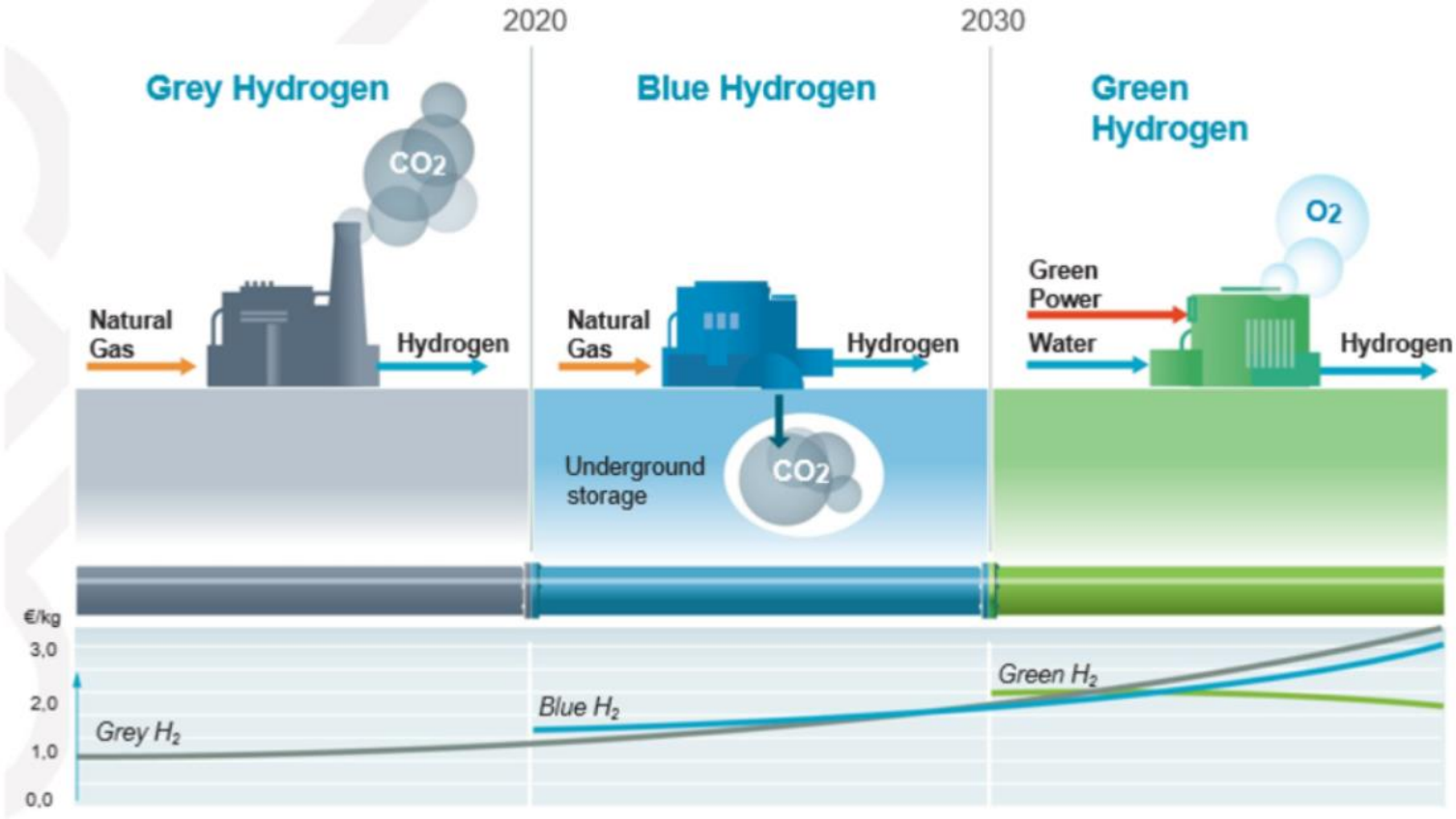
Utilization

(Heavy) transport



Industry

Hydrogen colors

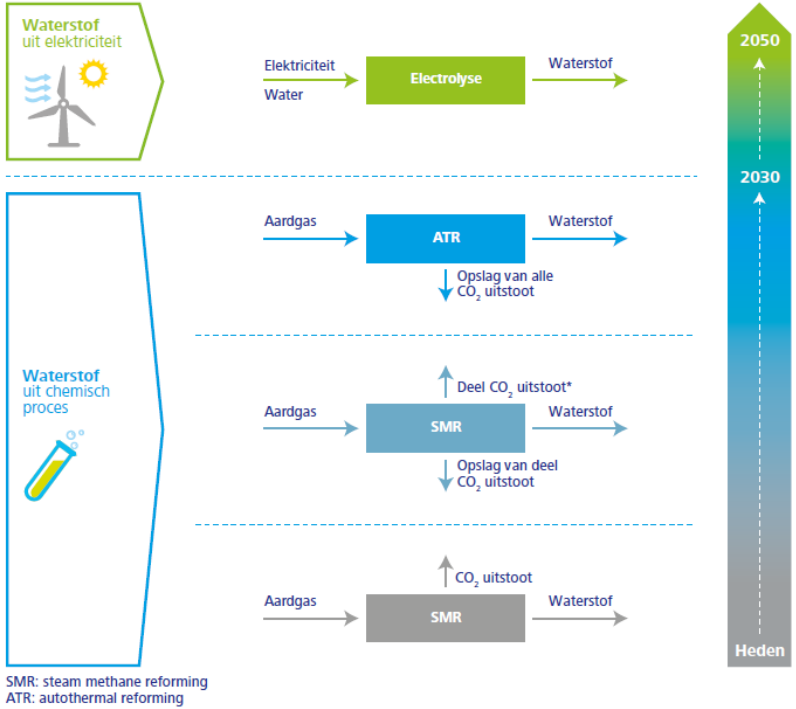


Source: tno.nl

The Netherlands should only focus on the production of green hydrogen.

Blue is greener than grey

Domestic hydrogen production



SMR: steam methane reforming
ATR: autothermal reforming

Offshore wind target 2030: 92 TWh

Power demand NL 2030: 200 TWh

Available green electricity is bottle neck for green hydrogen

Blue is greener than grey

Hydrogen use industry

Final demand (2280 PJ)
Energy carriers

	17%	389 PJ Electricity (108 TWh)
	10%	219 PJ Heat
	25%	570 PJ Direct use of gas
	25%	566 PJ Transport fuel and residual gas
	23%	Products and feedstock (non energetic demand)

524 PJ
(incl. 180 PJ of hydrogen)

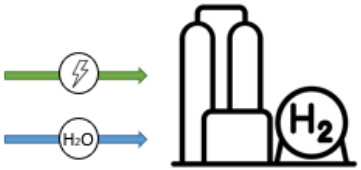
Offshore wind:
now ~2.4 GW installed
Targets: 21 GW in 2031
70 GW in 2050

11 GW offshore wind

EBN, 2022 – www.energieinnederland.nl

Value chain

Production

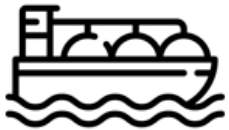


Electrolysis

Methane reforming
(SMR or ATR)

Transport

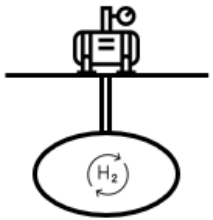
Pipeline



Ship
(several options)

Storage

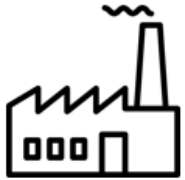
Tanks



Underground

Utilization

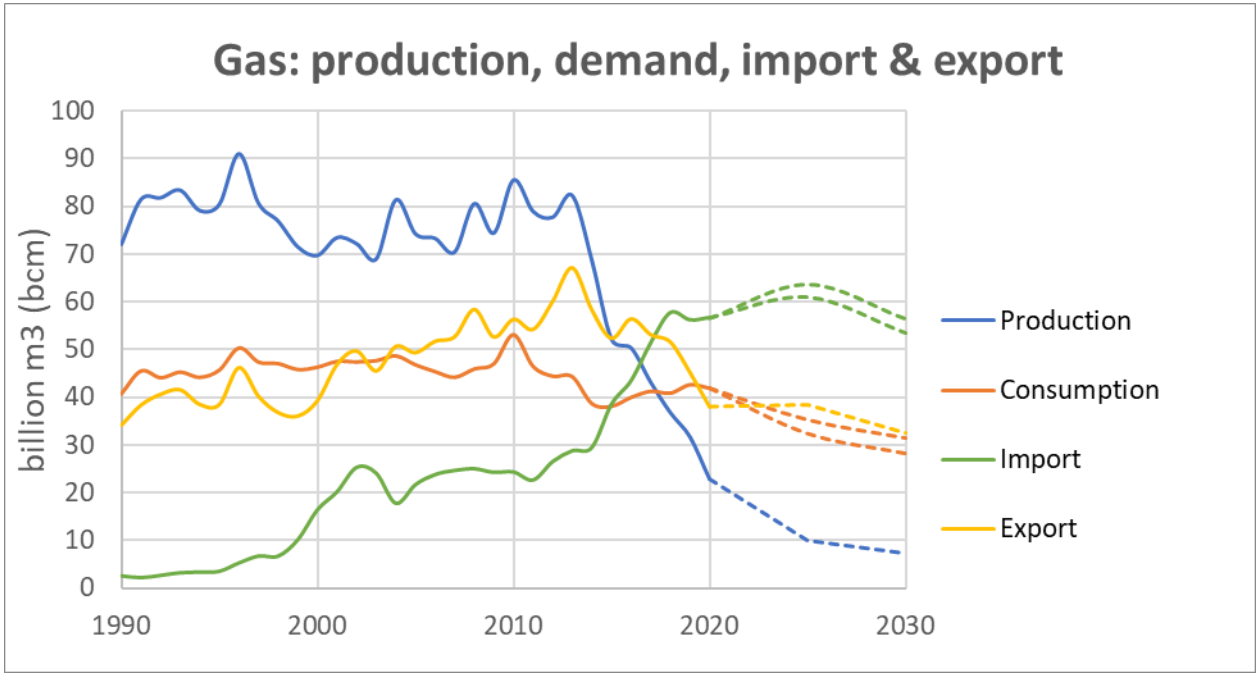
(Heavy) transport



Industry

Evolution of the Dutch energy system

Result of Groningen shut-in: increase of dependency on gas imports

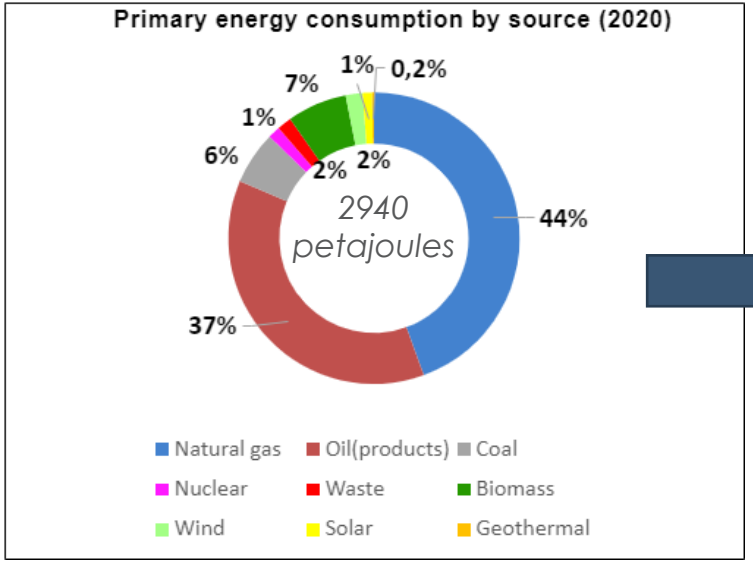


In 2018 the Netherlands became a **net importer** of natural gas

EBN, 2022 – www.energieinnederland.nl

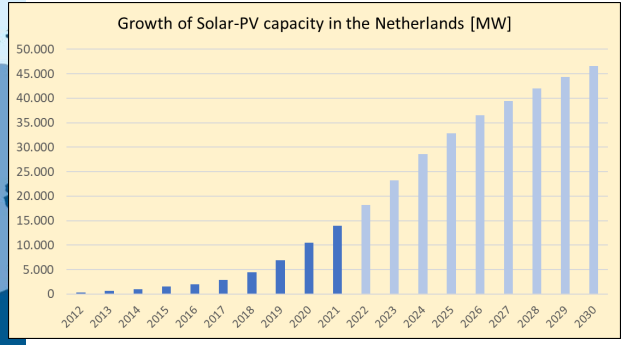
The Netherlands should focus on the import of “cheap” hydrogen.

Energy consumption and production

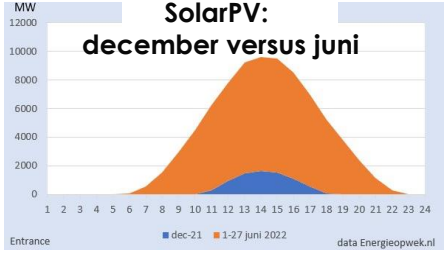


N.B. 3,6 PJ = 1 TWh = 1 miljard kWh

Offshore wind target 2050:
70 GW in 2050 => ~ 1.100 PJ/a

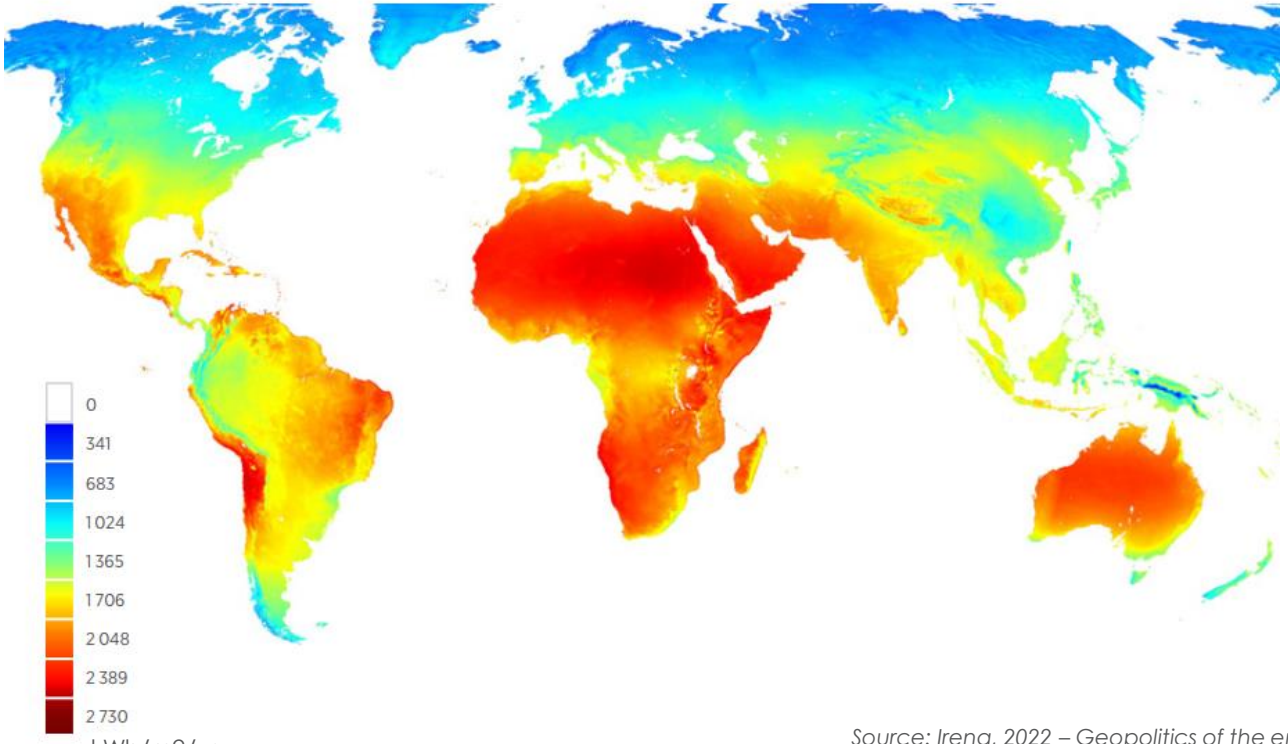


Rapidly increasing, 2050 could be:
100 GW => ~ 288 PJ /a



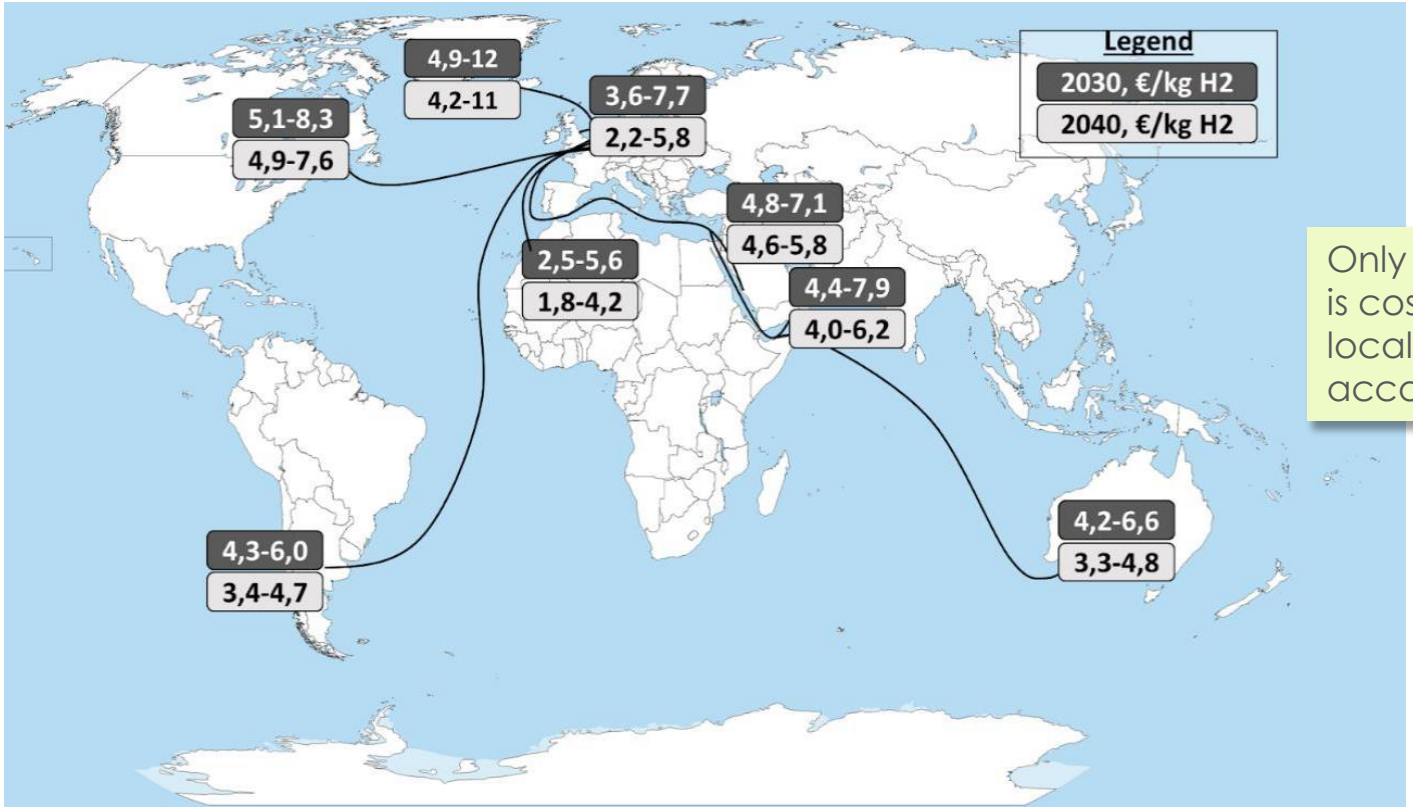
Renewable electricity from solar will be cheaper outside Europe

Figure 2.6 World solar technical potential



Source: Irena, 2022 – Geopolitics of the energy transformation – the hydrogen factor

Total costs of H2, including transport to Rotterdam

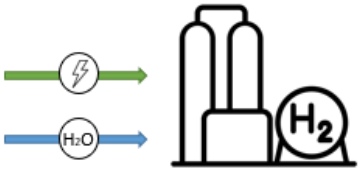


Only import from Marocco is cost competitive with local production, according to this analysis

Source: TNO, 2022 HyDelta

Value chain

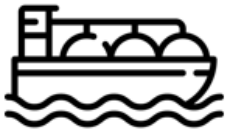
Production | Transport | Storage | Utilization



Electrolysis

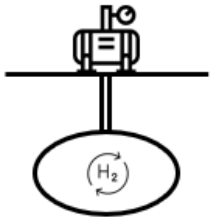
Methane reforming
(SMR or ATR)

Pipeline



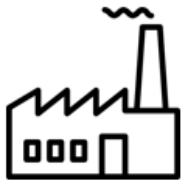
Ship
(several options)

Tanks



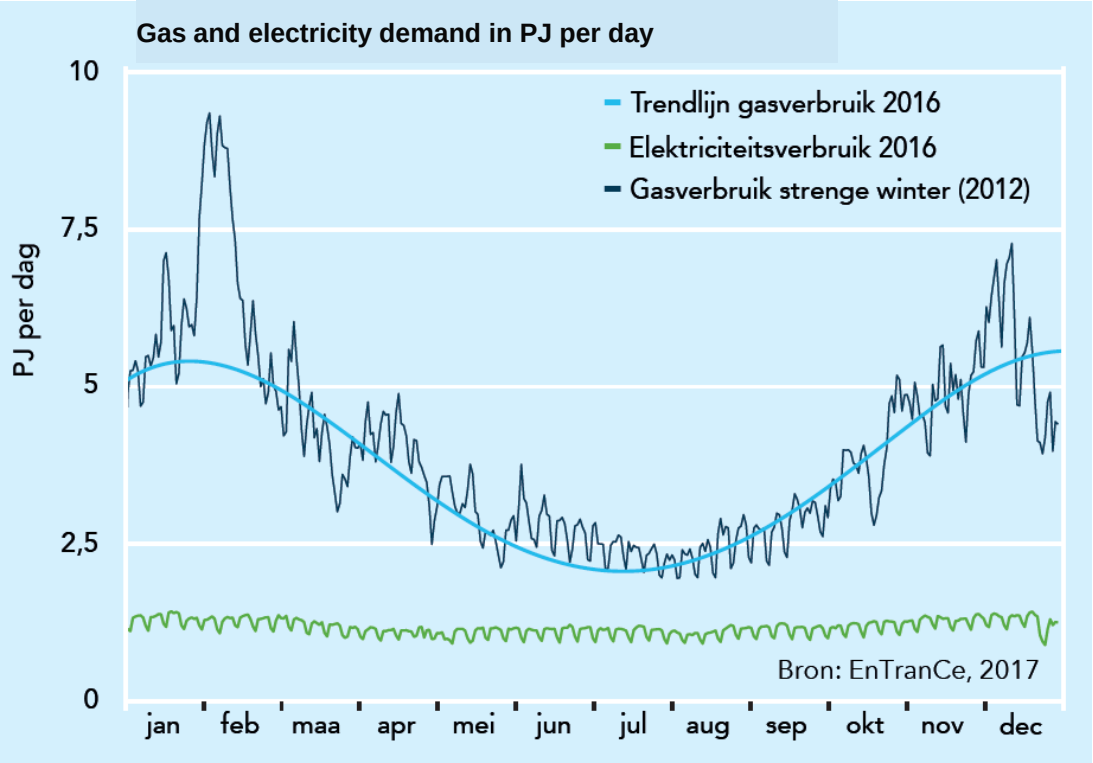
Underground

(Heavy) transport

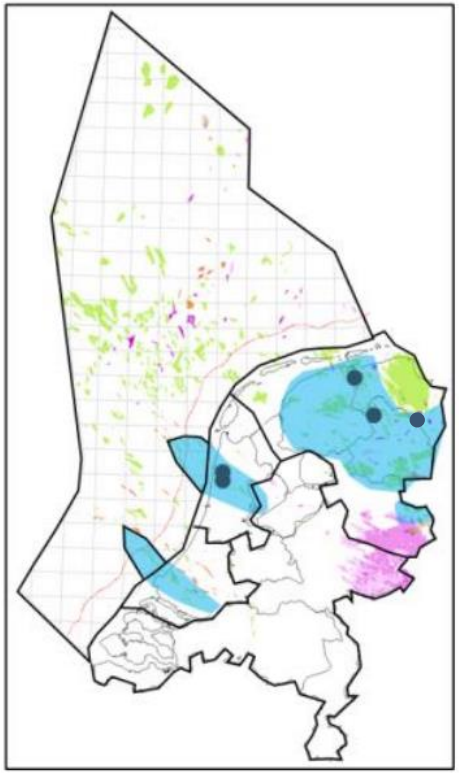


Industry

Large-scale energy storage in The Netherlands

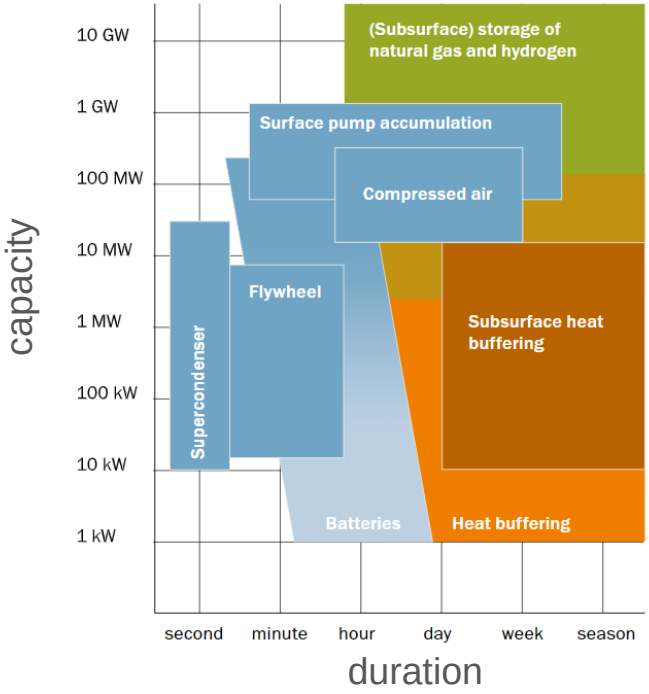


Current gas storages NL: 32 TWh

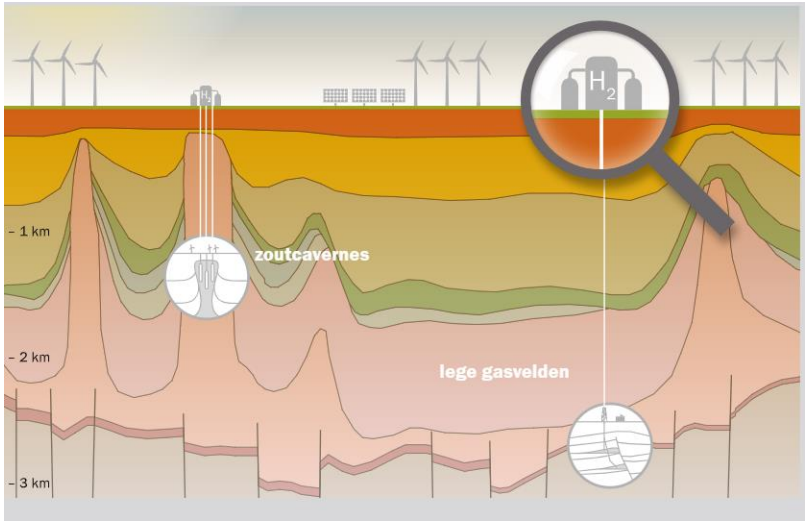


Source: EBN & TNO, 2020

Energy storage in The Netherlands



Subsurface hydrogen storage

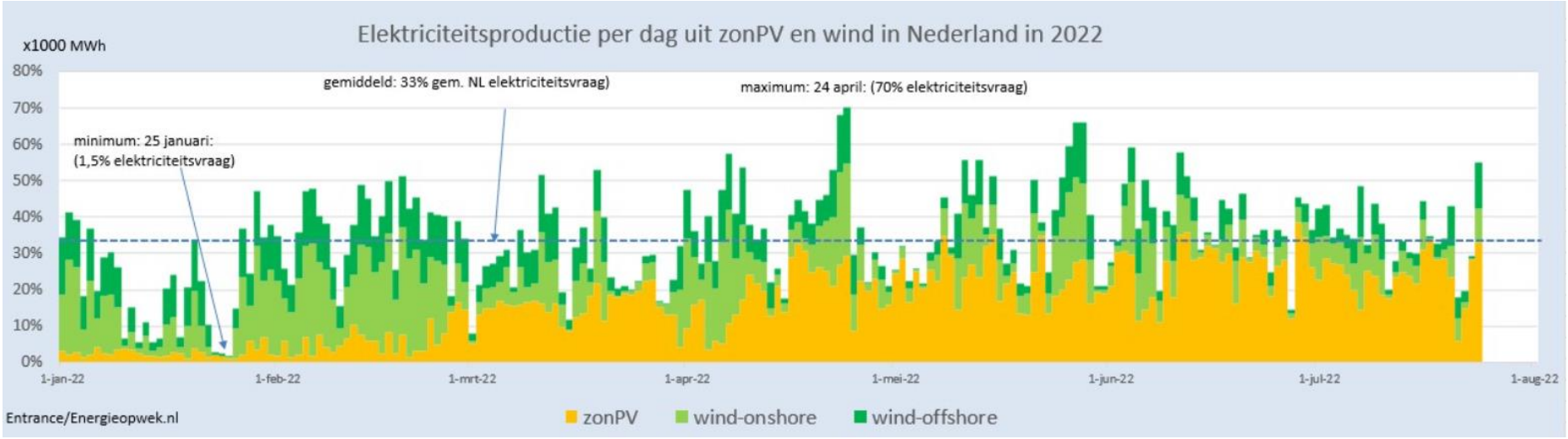


Source: TNO & EBN, 2020

Source: TNO & EBN, 2021 - SUBSURFACE ENERGY STORAGE IS ESSENTIAL FOR THE FUTURE ENERGY SYSTEM

Large-scale hydrogen storage is a necessity in our future energy system.

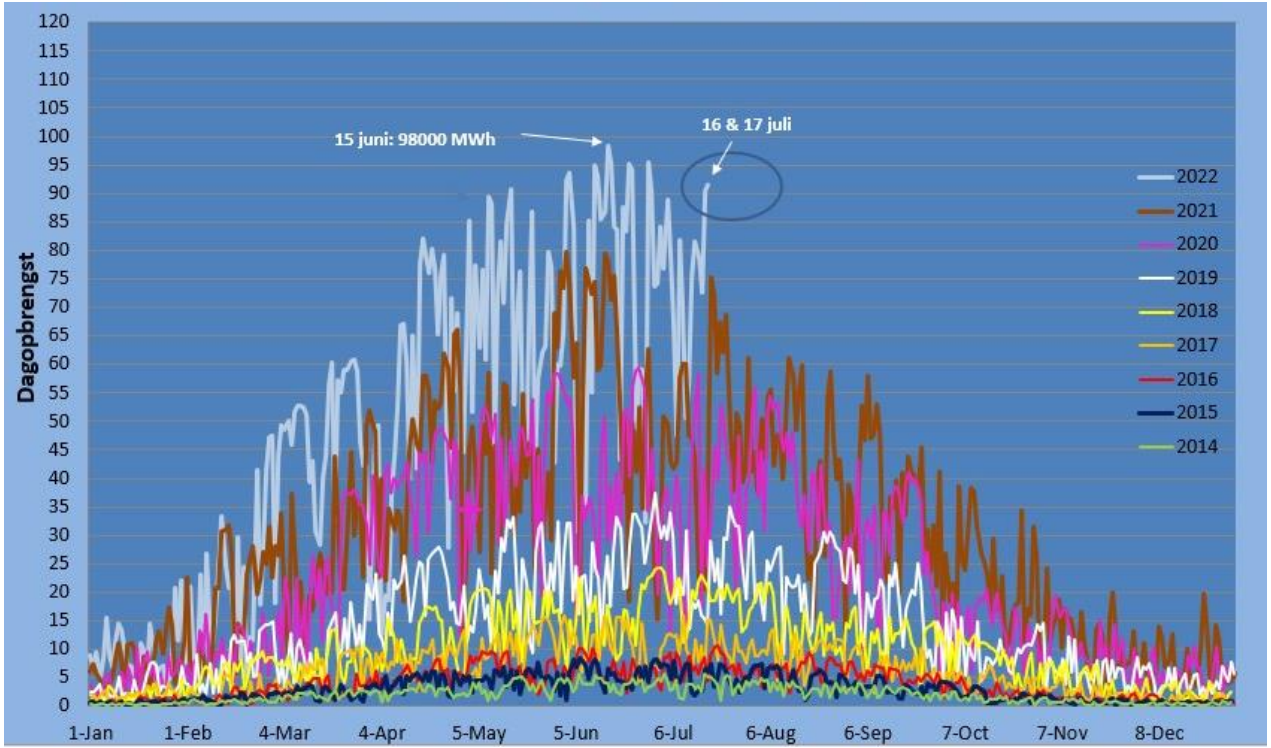
Production fluctuations increase

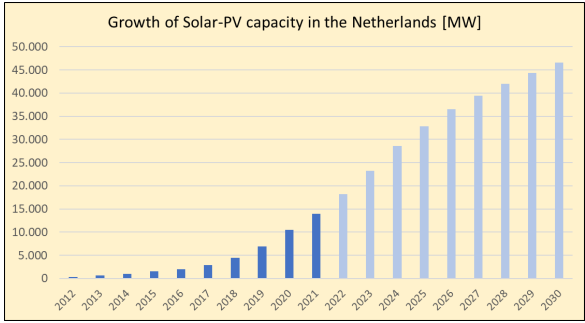


Bron: Martien Visser, Twitter

The rapid growth of solar-PV and its limitations

Daily yield of electricity from solar-PV in the Netherlands [GWh per day]





Source: Martien Visser / EnTrance

Types of underground hydrogen storage

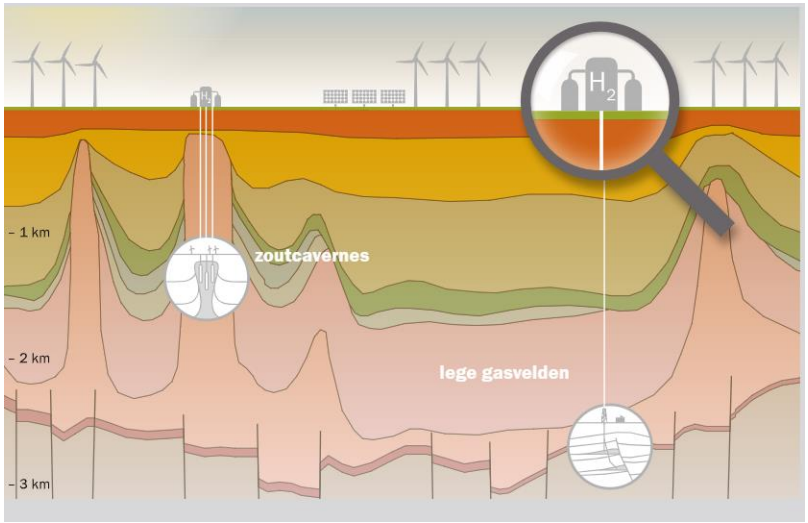
Three main types of storage can be distinguished:

1. Short cycle storage: Balancing **short-term fluctuations** in energy demand

2. Seasonal storage: Large-scale storage of hydrogen for **seasonal fluctuations** in demand

3. Strategic storage: Storage for **security of supply** by unexpected circumstances

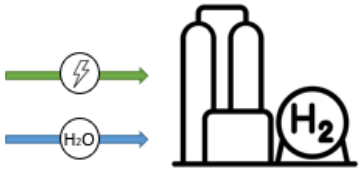
Subsurface hydrogen storage



Source: TNO & EBN, 2020

Value chain

Production



Electrolysis

Methane reforming
(SMR or ATR)

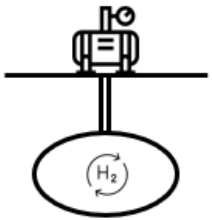
Transport

Pipeline

Ship
(several options)

Storage

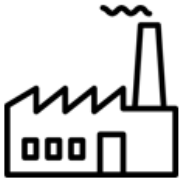
Tanks



Underground

Utilization

(Heavy) transport



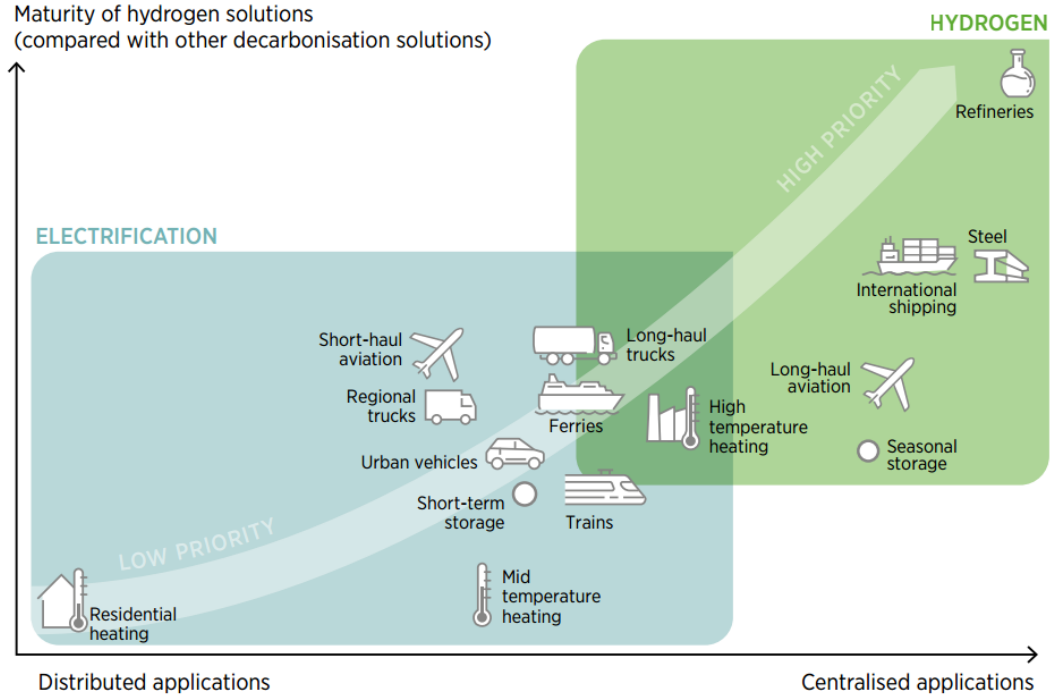
Industry


TOKYO 2020

In 2050 most of the sectors will use hydrogen as main energy carrier.

Potential roles for hydrogen besides system role

in particular industry and transport



Hydrogen can be used in **industry**

- high temperatures processing (replacement natural gas)
- where industrial processes need flames (e.g. the glass industry)
- as a feedstock or reduction agent (like in steel making)

And in the **heavy transport** section, where electricity and batteries are a difficult option

Source: Irena, 2022 – Geopolitics of the energy transformation – the hydrogen factor

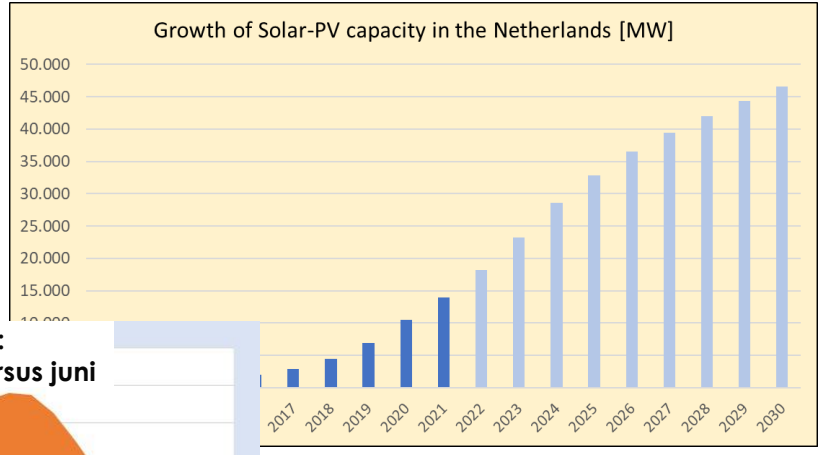
Thanks you for your attention

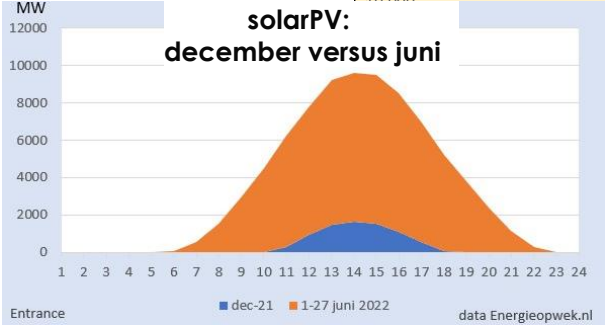
The Netherlands is going to rely on offshore wind

and solar PV, a bit of geothermal energy and biomass (under debate)

Offshore wind:
now ~2.4 GW installed
Targets: 21 GW in 2031
70 GW in 2050
=> ~ 1.100 PJ/a

Solar PV:
now (2022) ~10 GW
and rapidly growing!
but has serious limitations



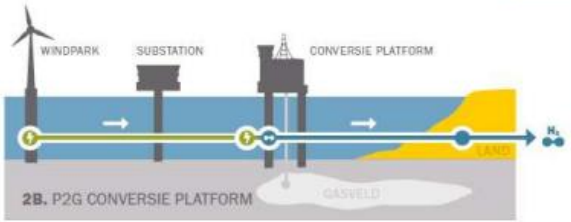


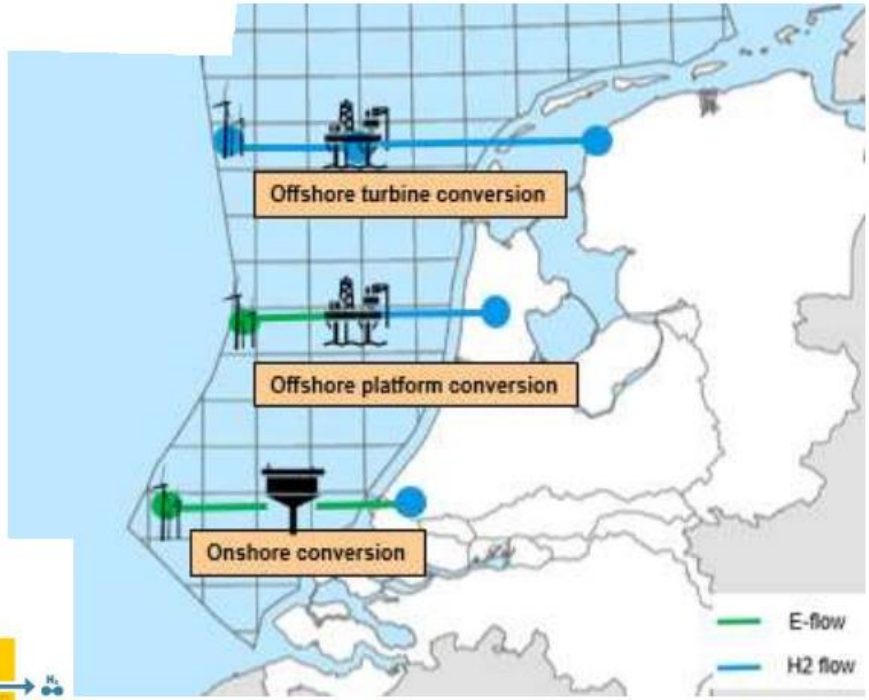
100 GW solar would result in ~288 PJ /a

Conversion of windpower to hydrogen

Optimisation of hydrogen production from far offshore wind

1. Energy efficiency
2. Cost efficiency
3. Options for reuse pipelines





Source: TNO, 2020

Dutch hydrogen demand is still uncertain

Selection of results from most relevant and most recent 2020 scenario studies