



Status of the energy transition in the Netherlands

Snapshots of developments and challenges

Dr. Frank Lenzmann (TNO)

November 10th 2023

Most information extracted from the recently published Climate and Energy Assessment (KEV) 2023

([Klimaat- en Energieverkenning \(KEV\) | PBL Planbureau voor de Leefomgeving](#))

Overview

- Short intro TNO
- Status energy transition in the Netherlands and Czechia
- Dutch Climate and Energy Assessment 2023
- Solar energy in the Netherlands
- Wind energy in the Netherlands
- Challenges for the energy transition in the Netherlands
- Solutions searched by innovation

TNO – Netherlands Organisation of Applied Scientific Research



TNO is a not for profit research and technology organization



Independent institute, with 3,600 professionals



Turnover of 570 M€ in 2021 of which 18% international



With depth and breadth of knowledge, and linked to academia



Focused on multi-disciplinary, smart solutions to complex issues on systems level



With the aim of sustainably strengthening the competitiveness of enterprises and the well-being of our society



Together with partners: companies, organizations at home and abroad



Located in The Netherlands, but active worldwide

TNO connects people and knowledge to create innovations

that boost the competitive strength of industry and the well-being of society in a sustainable way.

TNO Energy & Materials Transition

Four (integrated) innovation programs: focus on big challenges in the energy transition.

Renewable Electricity

System Transition

CO₂ Neutral Industry

Sustainable Subsurface

**Circular Economy &
Environment**

- Solar PV development & integration & Offshore wind optimization
- Energy system modelling & Strategic, social & economic analysis
- Green Hydrogen, Decarbonization of industry, Sustainable fuels
- Geothermal, CCS, Storage (energy & water)
- Emissions, air pollution, (e)-waste management and plastics

Czechia and the Netherlands – some figures



	Czechia	The Netherlands
Population (million)	10,5	17,8
Land area (km ²)	78.866	41.543
GDP (billion US\$)	472	1.200
Total energy supply, 2020, IEA (PJ)	1682	2903
<i>Share of RE* (%)</i>	<i>12,6</i>	<i>10,5</i>
Total electricity generation, 2021, IEA (TWh)	83	120
<i>Share of RE (%)</i>	<i>14</i>	<i>35</i>

*Including biomass and waste

Climate and Energy Assessment in NL (an annually issued report)



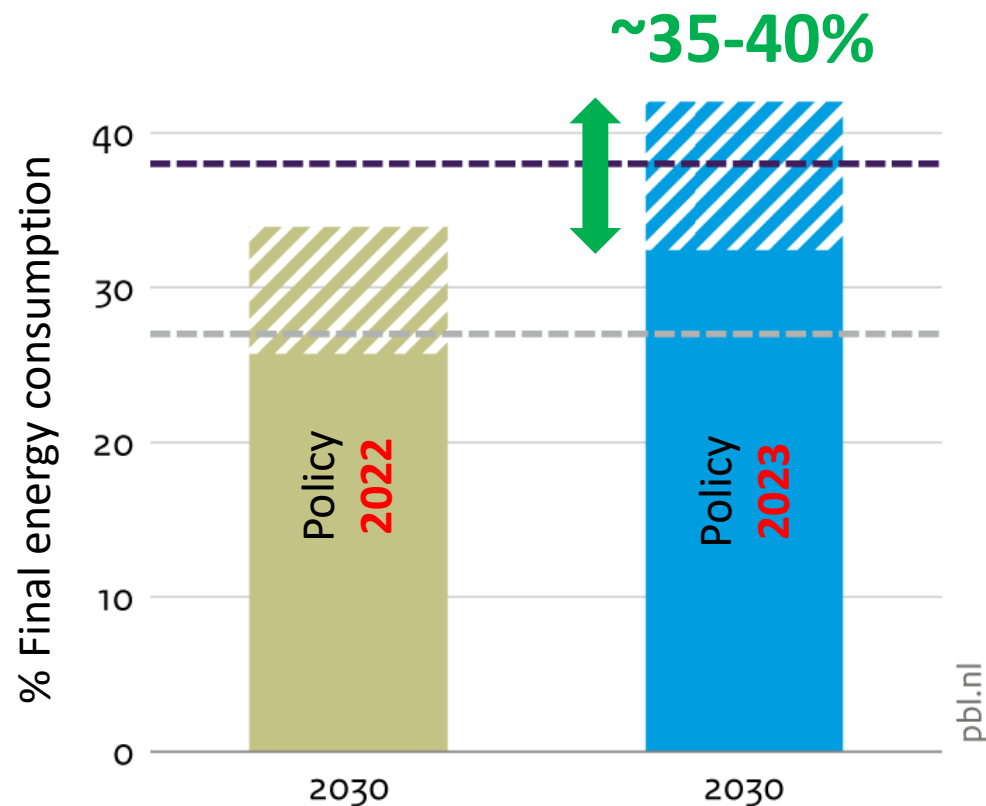
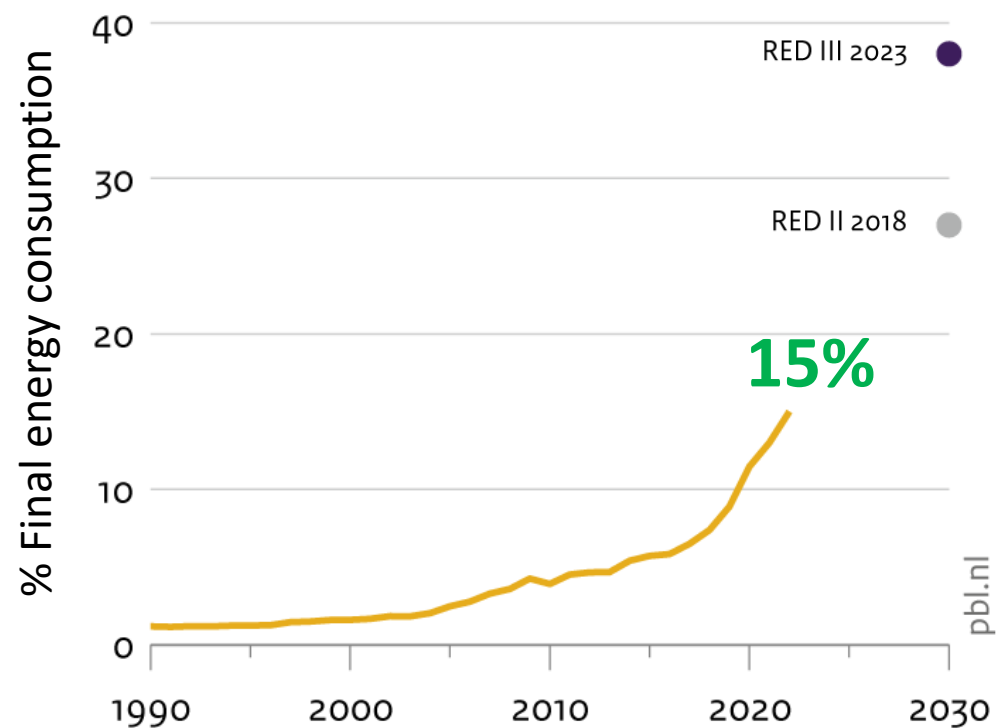
The 2023 version of this report was published on 26-10-2023:

- **Update of Dutch Climate Law (2023)** to comply with the EU Climate Law (EU Regulation 2021/1119).
- Updated goal CO2 reduction: **55% in 2030** compared with 1990
- Updated Dutch **regulations in line with reduction goal** if implementation occurs as planned.

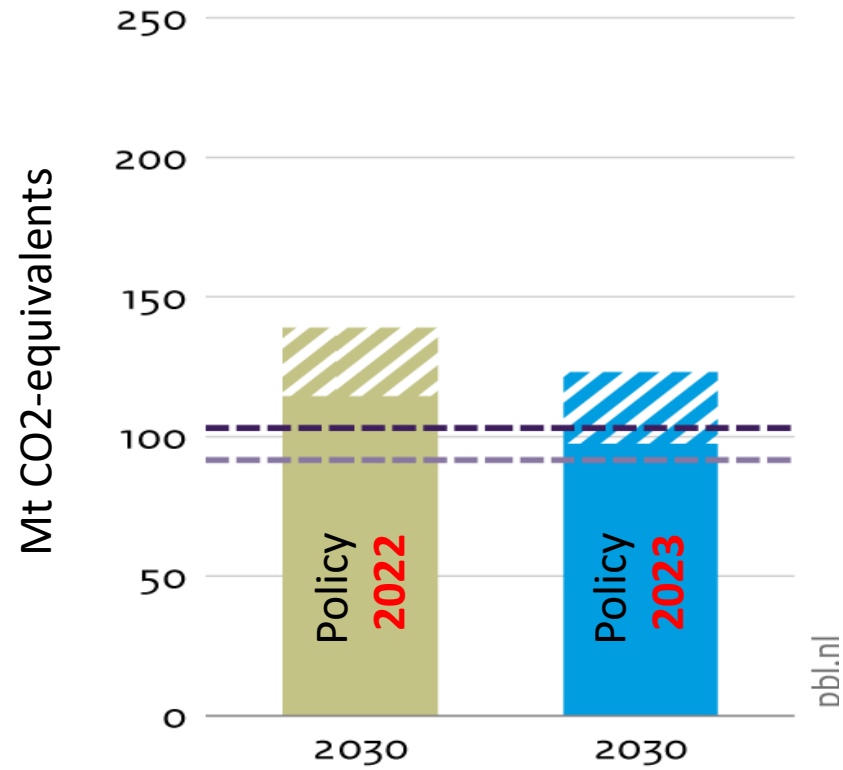
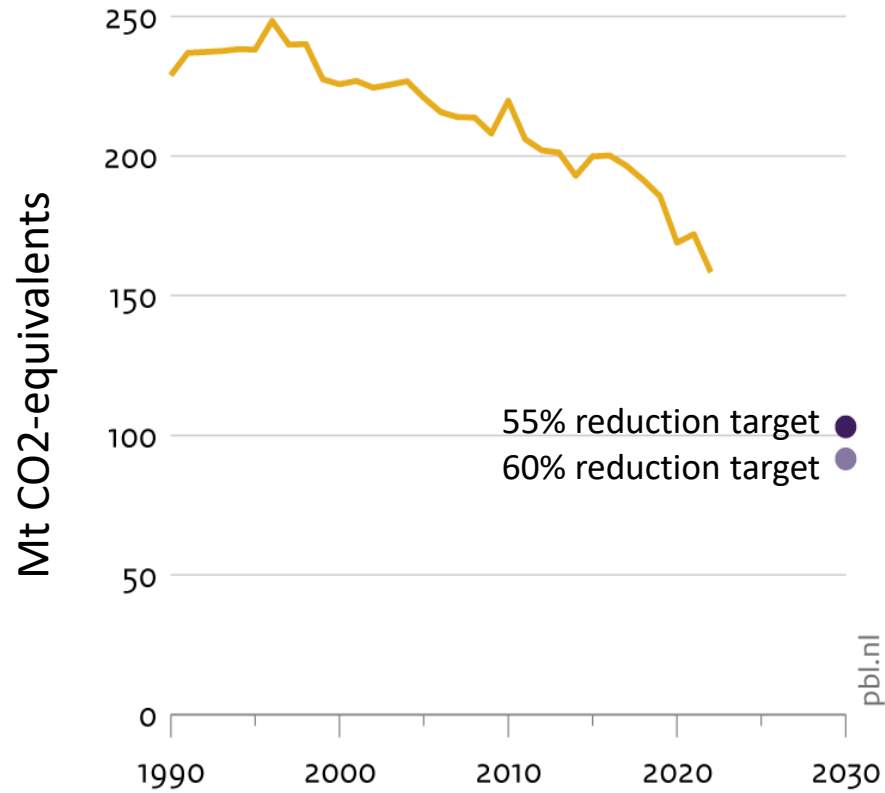
This implies compliance with:

- *EU Energy Efficiency Directive: update EED 2023/1791*
11,7% lowering of primary energy consumption
(compared with goals agreed in 2020)
- *EU Renewable Energy Directive: update RED 2023/2413*
42,5 – 45% renewable energies in overall energy consumption

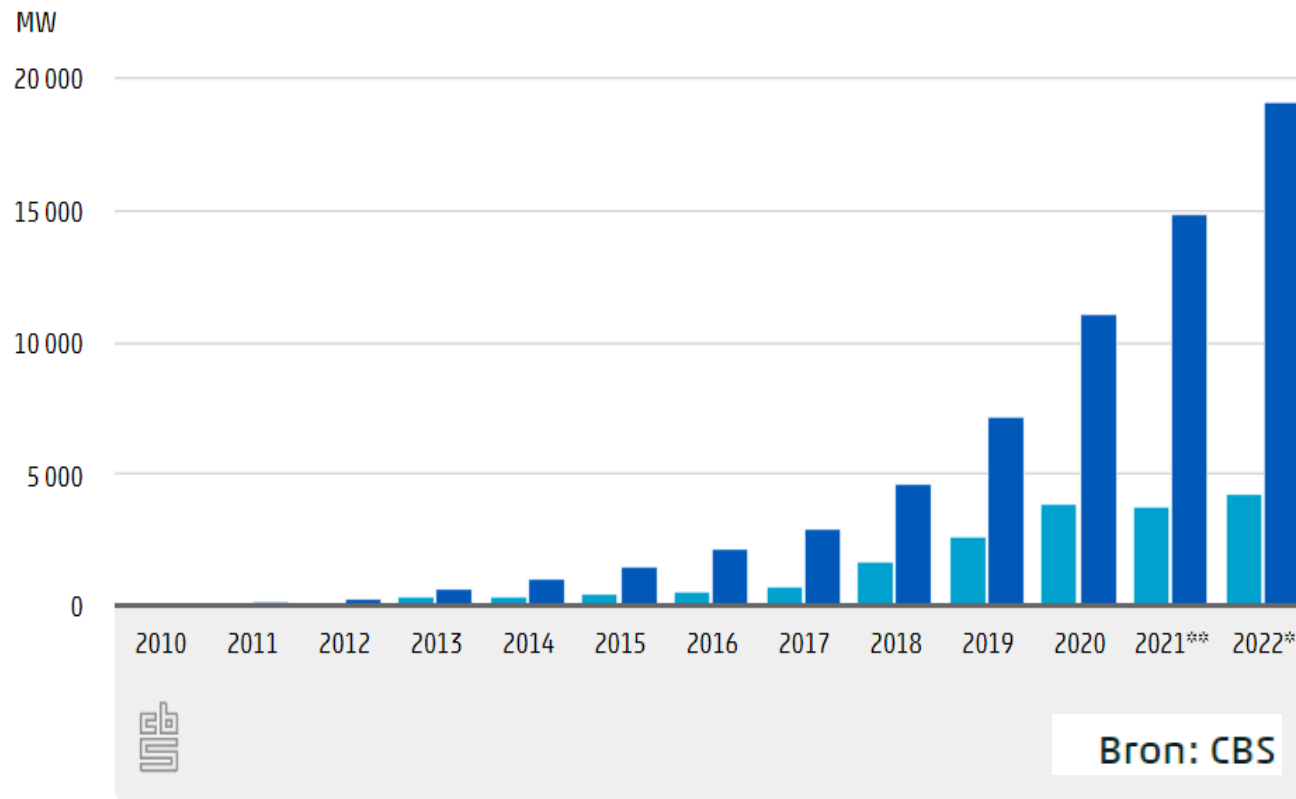
Development of renewable energies in NL (1990 – 2022 and prospects till 2030)



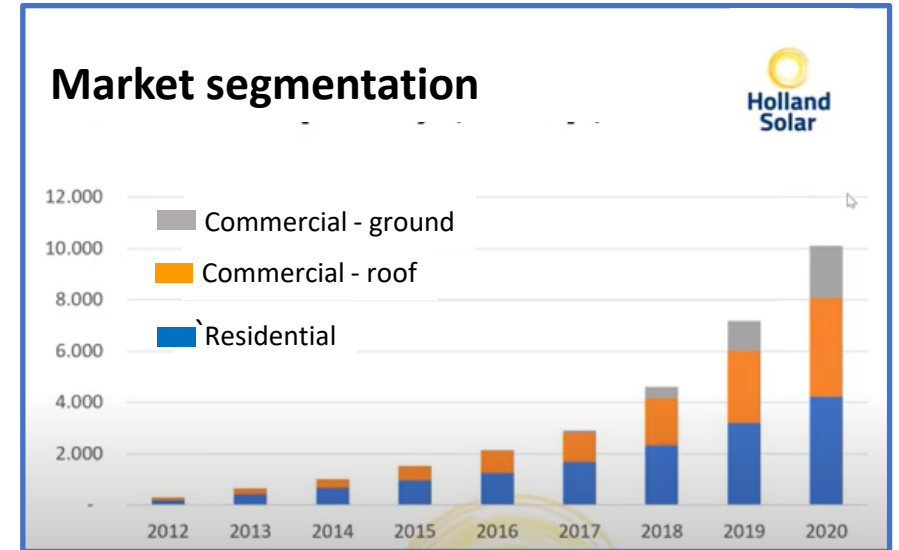
Development of greenhouse gas emissions in NL (1990 – 2022 and prospects till 2030)



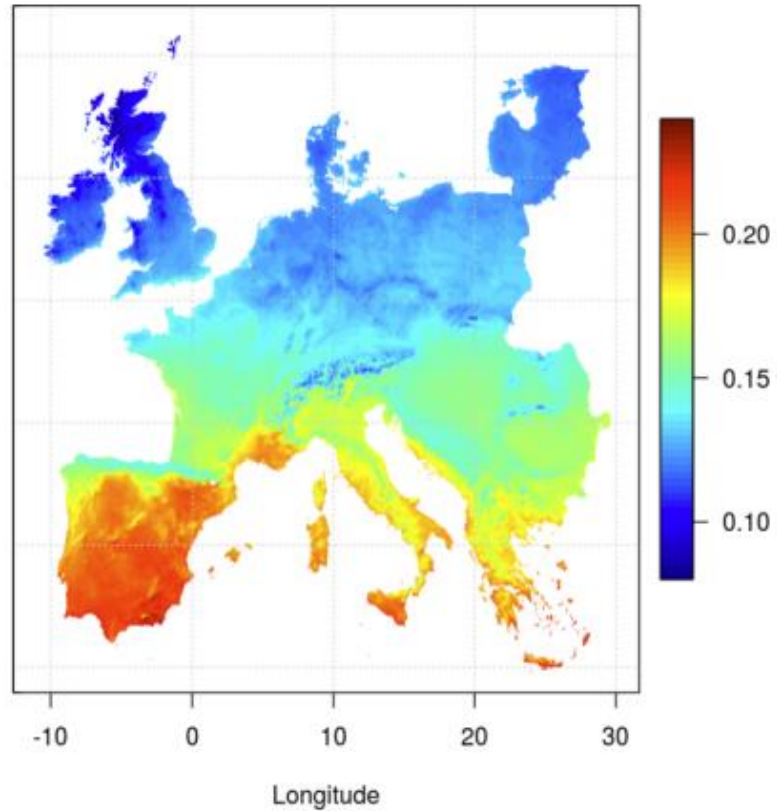
Growth of PV capacity (2010 – 2022)



■ Added capacity
 ■ Cumulative capacity



Capacity factors of PV across Europe



The capacity factor of PV ranges from about 10-20% across Europe.

In the **Netherlands** as well as in **Czechia** it is at the lower end of this range, i.e., **~10%**

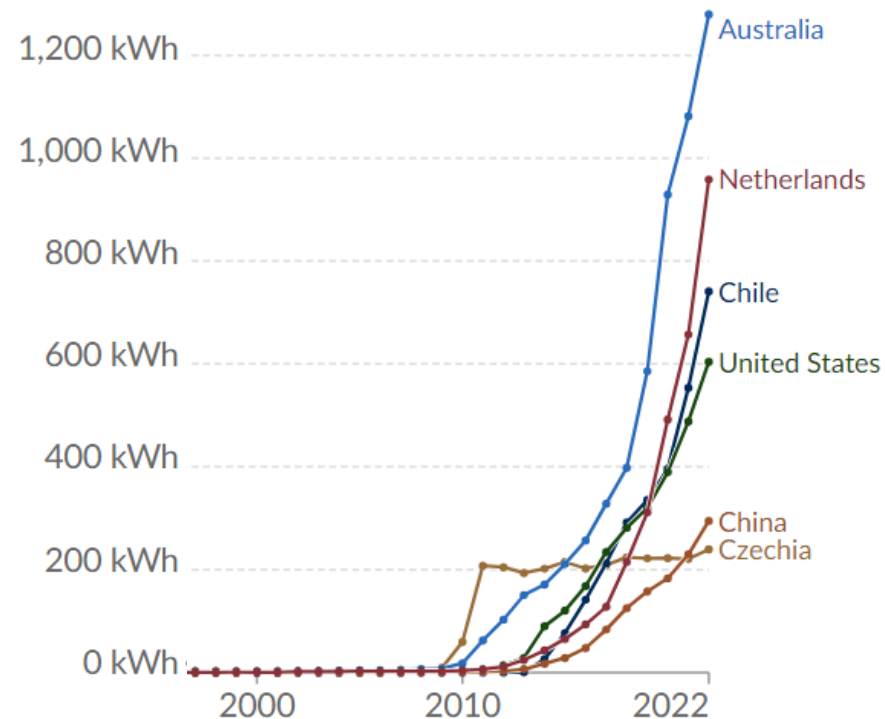
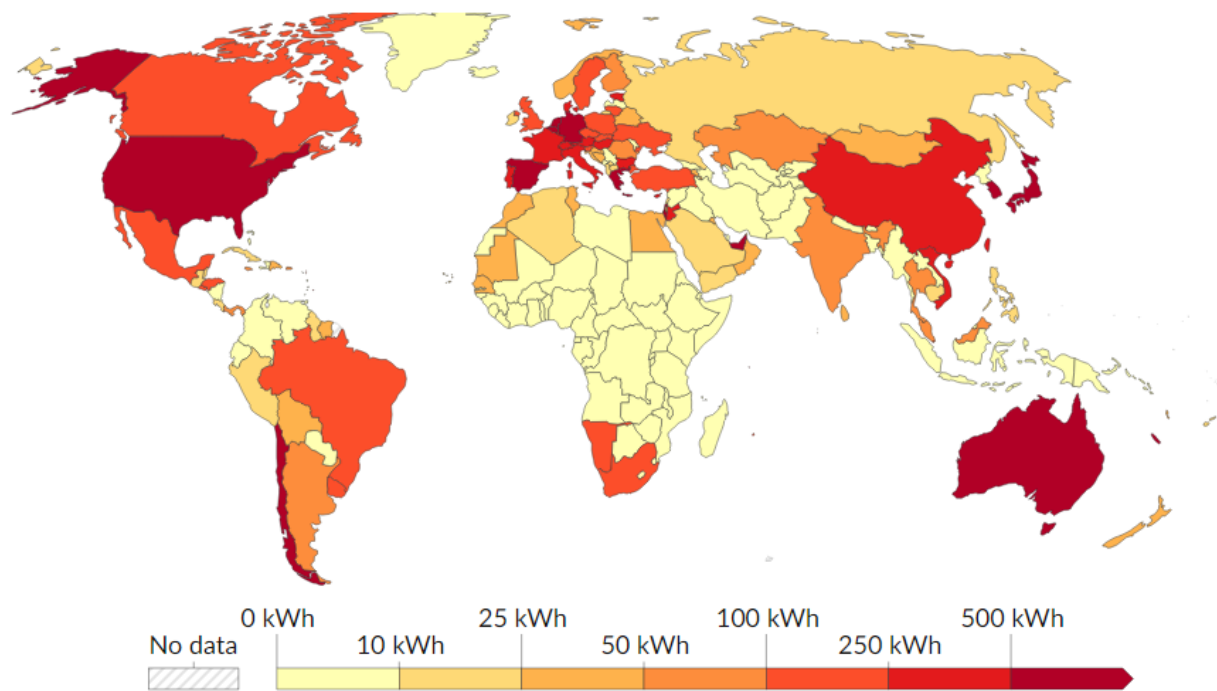
Source: F. Kaspar et al., "Balancing effects and shortfall risks of photovoltaics and wind energy", *Adv. Sci. Res.*, 16, 119–128 (2019)

PV electricity generation and avoided CO2 emissions in NL (2010 – 2022)

	Electricity generation (GWh)	Avoided fossil fuel consumption (TJ)	Avoided CO2 emissions (kt)
2010	56	476	32
2015	1 109	9 639	751
2020	8 765	65 736	3 727
2021**	11 495	92 074	5 842
2022**	16 827	134 790	8 553

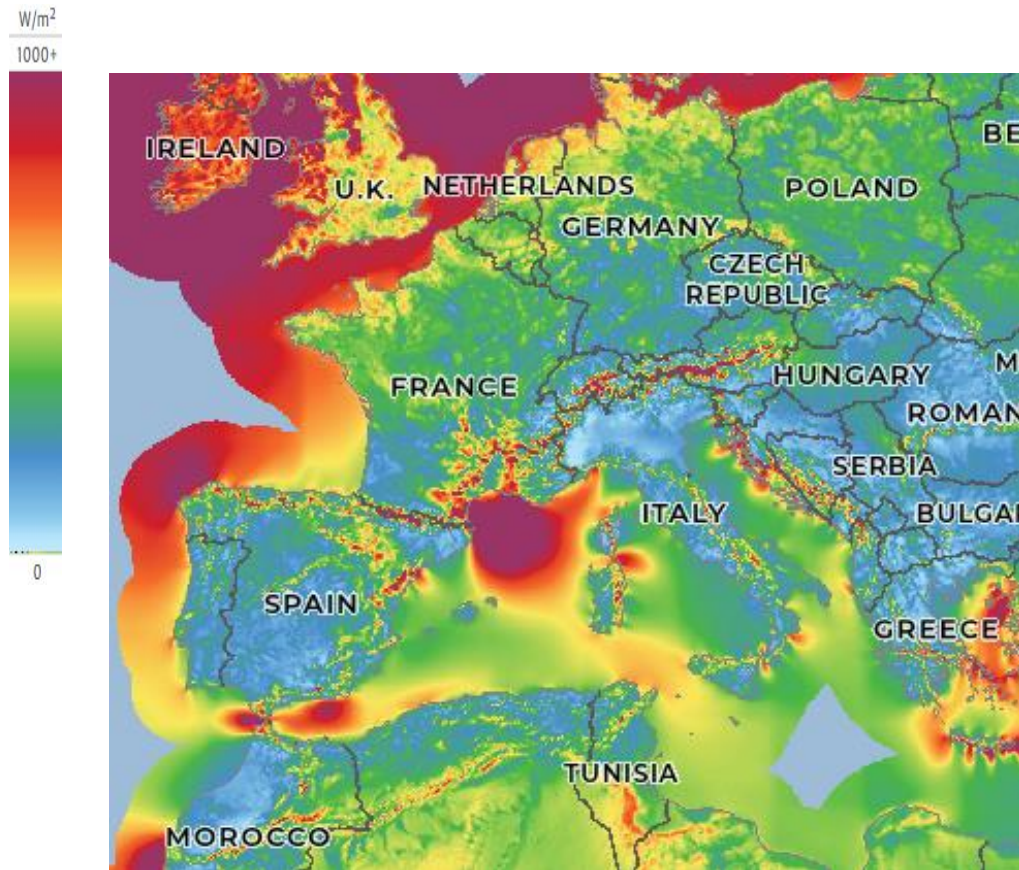
Bron: CBS

PV electricity generation per capita (2022)



[Per capita electricity generation from solar, 2022 \(ourworldindata.org\)](https://ourworldindata.org)

Huge potential for offshore wind in the Dutch part of the North Sea



Current capacity 2023: 4,7 GW

Target of Dutch government 2050: 70 GW

Steps: 20 GW (2030), 50 GW (2040), 70 GW (2050)



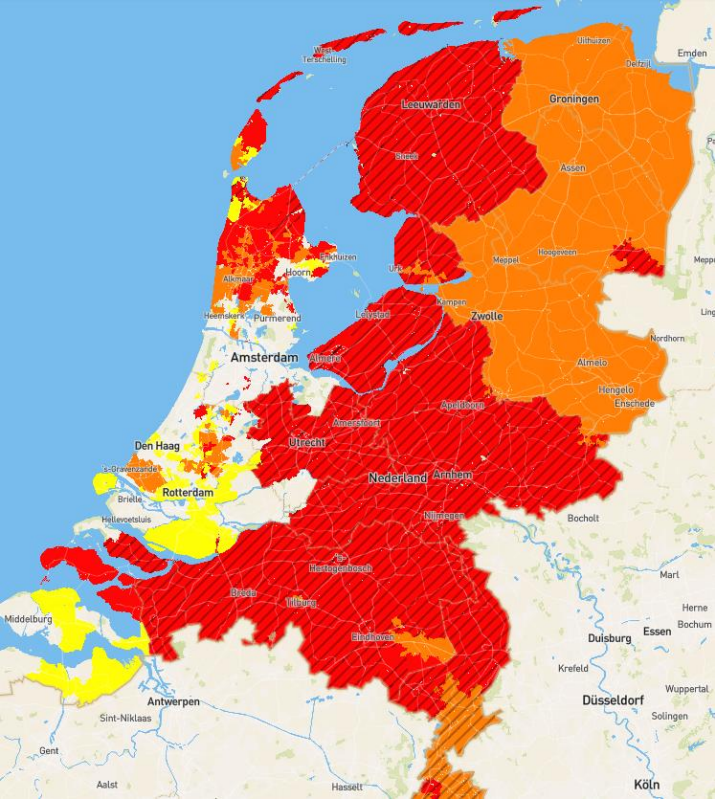
Great!

But...

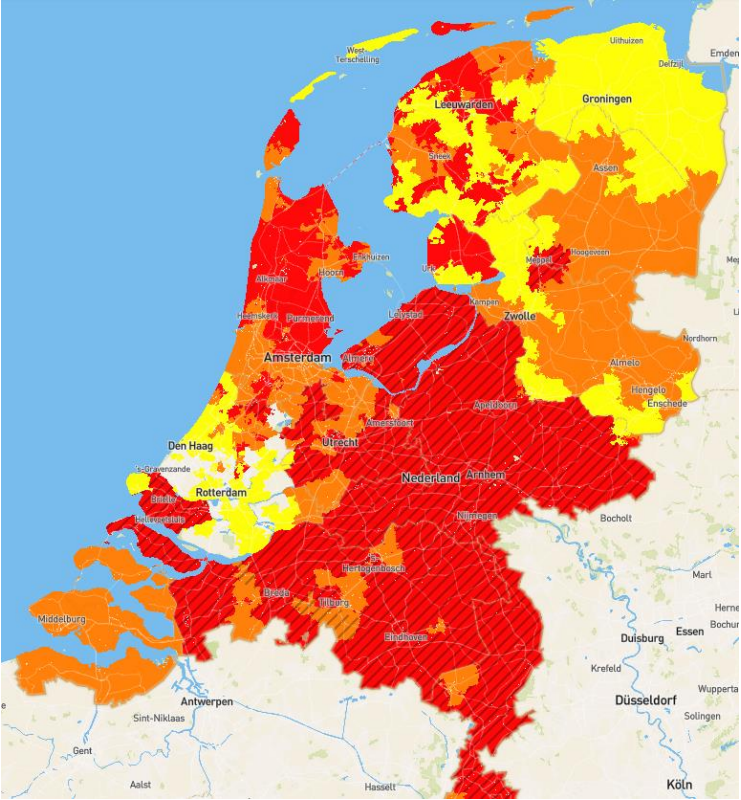
Citizens protests – limited but need attention






Congestion of the electricity grid



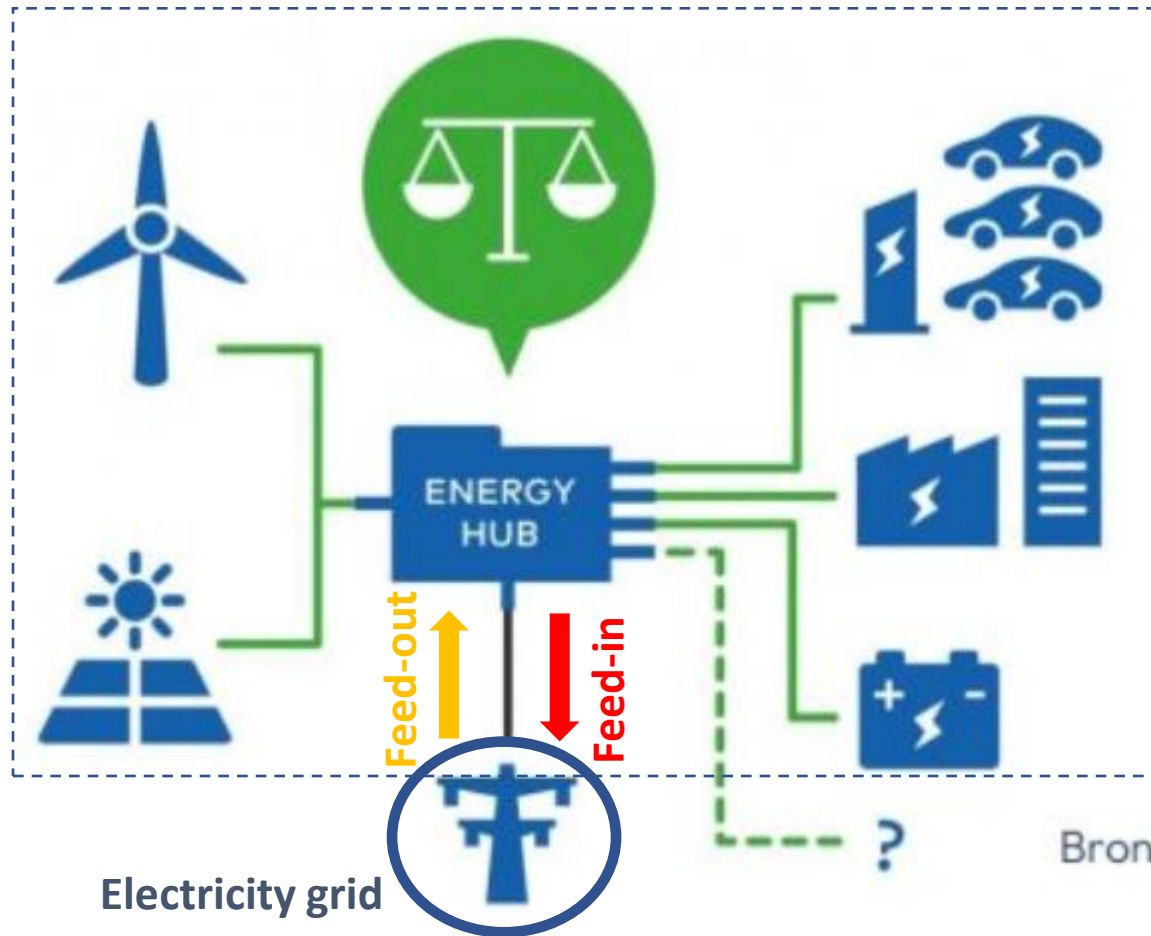
Feed-in



Feed-out

-  Limited transport capacity
-  No transport capacity unless congestion management research delivers solutions
-  No transport capacity

Development of “energy hubs”



Energy hub =

Limited cluster, e.g. business park, where agreements about local balancing of energy supply and demand are made to the effect that feed-out from the electricity grid to the cluster as well as feed-in from the cluster to the grid are minimized.

See, e.g.:

<https://www.egen.green/news/eigen-project/>

Bron: Firan

SENSE-HUB project by TNO and consortium



Projectconsortium / Project consortium

SPRANG-CAPELLE

Advanced Electromagnetics B.V.

DELFT

Deltares

DEN HOORN

Koninklijk N.I.O.Z.

AMSTERDAM

NewGround Law B.V.

VALKENBURG

Oceans of Energy B.V.

ROTTERDAM

Primo Consultants Rotterdam

'S-GRAVENHAGE

TNO

R&D project to optimize large potential of offshore energy generation by integrating offshore wind, photovoltaics and on-site production of green hydrogen

Projectinformatie / Project information

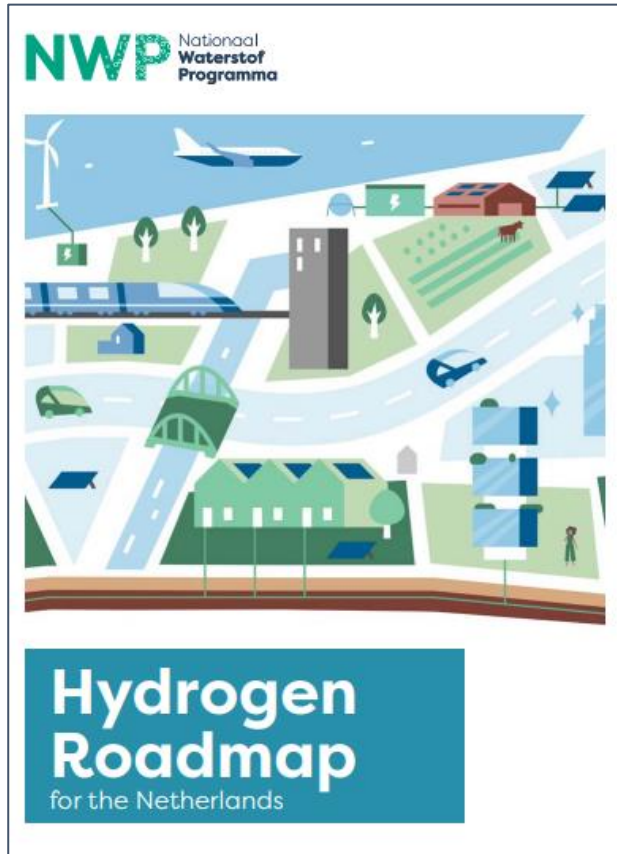
Projectnummer / Project number

MOOI622002

Subsidiebedrag / Grant amount

€ 3.745.130,00

Green hydrogen is high on Dutch innovation agenda



National Hydrogen Program (operational since 2023)



Also at TNO:



'The fact that we are reducing the required iridium by a factor of 200, while already achieving an average of one third of the performance of current electrolyzers, is a technological breakthrough.'

Lennart van der Burg - Program and business developer TNO

Conclusions

- **Current status: still low share of RE in total energy mix (15%), but signs of awakening**
- **Target of 35 – 40% RE in reach**
- **Large expansion of photovoltaics since 2015, current status ~20 GW (2023)**
- **Major plans for offshore wind (70 GW by 2050) in combination with green hydrogen**
- **Energy hubs explored as solution for grid congestion**

Overview

The energy transition in the Netherlands is showing encouraging signs of an awakening in the past few years. From a level of merely 5% renewable energies in the total energy consumption up to the year 2015, this percentage has meanwhile increased to 15% (2022) and is expected to grow further to around 35 – 40 % by 2030. One of the most significant developments in the past few years are the major expansions of photovoltaic system installations which have reached a cumulative installed capacity of around 20 GWp today. In fact, with almost 1000 kWh of photovoltaic electricity generation per capita in 2022, the Netherlands has become a global champion in photovoltaics (only second to Australia where the per capita generation has been somewhat higher yet, ~ 1300 kWh). In my presentation, I will give snapshots of recent developments and challenges in the Dutch energy transition, including policy aspects and current bottlenecks (e.g., congestion of electricity grids).