



THE ENERGY SYSTEM NOW...

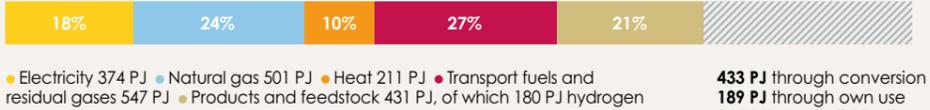
THESE ARE THE SOURCES OF OUR ENERGY (PRIMARY DEMAND)



2712 PJ*

24% is lost
648 PJ

THIS IS HOW ENERGY REACHES THE CONSUMER (FINAL DEMAND)

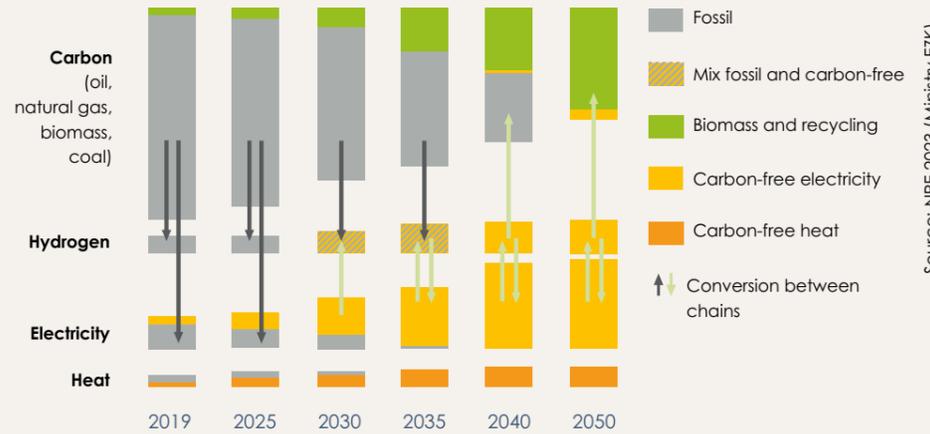


2064 PJ

433 PJ through conversion
189 PJ through own use
26 PJ through distribution
* excl. 15 PJ export of electricity

... AND IN THE FUTURE

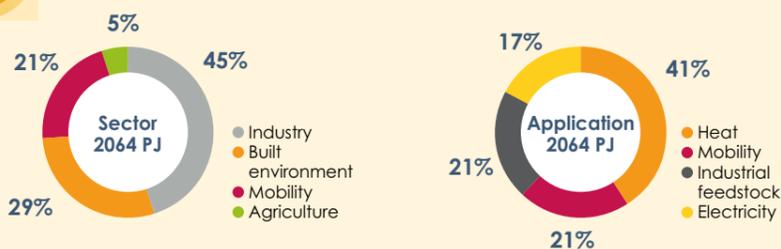
A SCHEMATIC REPRESENTATION OF THE ENERGY TRANSITION ALONG THE FOUR VALUE CHAINS



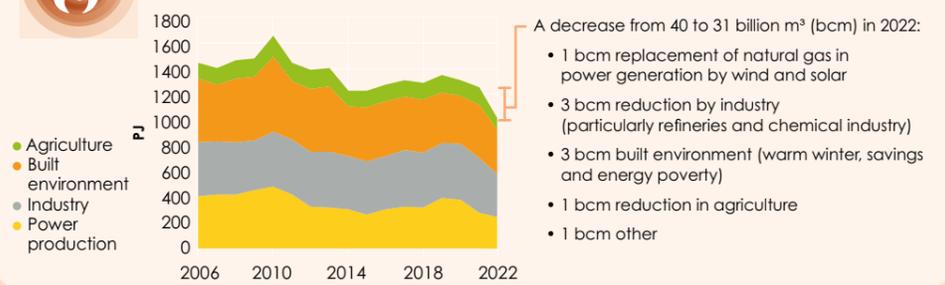
Source: NPE 2023 (Ministry EZK)



FINAL DEMAND PER SECTOR AND PER APPLICATION



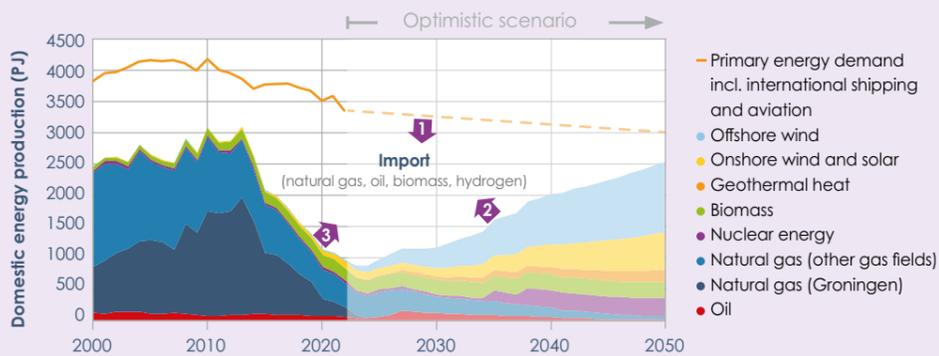
THE DEMAND OF NATURAL GAS



THE IMPORT GAP OF THE NETHERLANDS

OPTIONS TO CLOSE THE GAP

- 1 REDUCE ENERGY DEMAND
- 2 INCREASE RENEWABLE ENERGY PRODUCTION
- 3 SLOW DOWN THE DECLINE OF FOSSIL ENERGY PRODUCTION



CLIMATE PRICING DEFICIT

SCHEMES (FOSSIL SUBSIDIES) WITH LOW PRICING IN RELATION TO CLIMATE DAMAGE

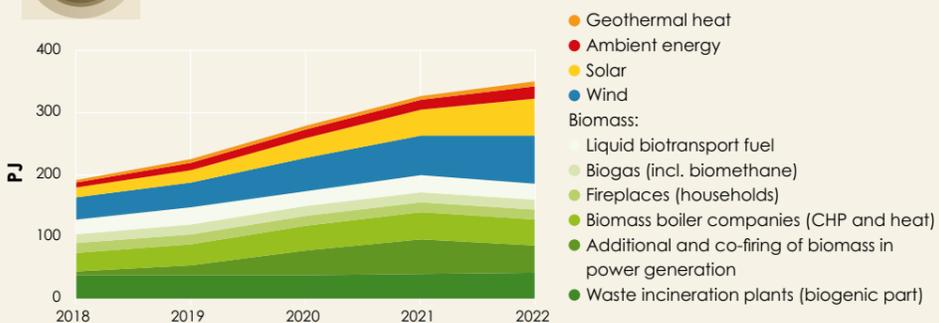


Source: Research into the abolition of fossil energy subsidies 2023 (CPB and PBL)

*Not quantified

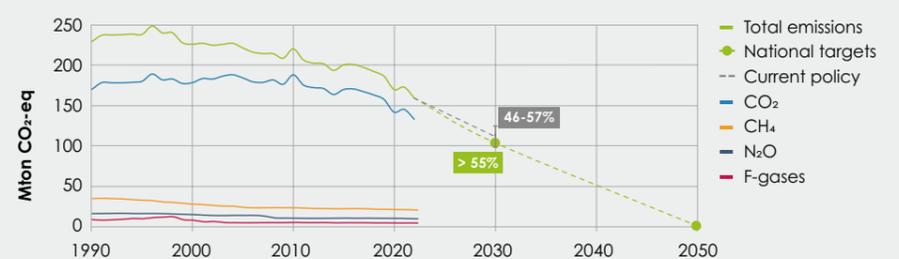


THE GROWTH OF RENEWABLE ENERGY



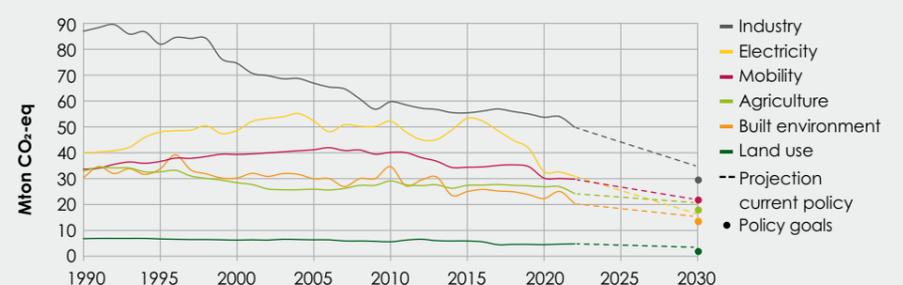
THE REDUCTION OF EMISSIONS

REGARDING POLICIES AND NATIONAL GOALS



Source: KEY 2023 (PBL)

IN THE SECTORS



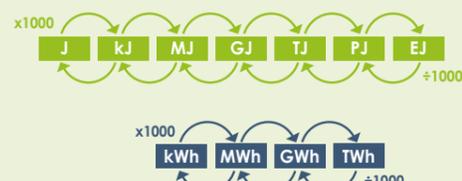
Source: KEY 2023 (PBL)



CONVERSION OF ENERGY UNITS

1 PETAJOULE (PJ) CAN PROVIDE A CITY LIKE TILBURG WITH ELECTRICITY FOR A YEAR

- 1 bcm natural gas (billion cubic meters = billion m³) = 35.17 PJ
- 1 TWh (Terawatt-hour = 10⁹ kilowatt hours) = 3.6 PJ
- 1 Mton waterstof (Mton = 10⁹ kilo) = 120 PJ
- 1 MBoe (million barrels of oil equivalent = 1 million barrels of oil) = 6.12 PJ





FOR A SUCCESSFUL ENERGY TRANSITION, A NUMBER OF CONDITIONS HAVE TO BE ADRESSED*

- Public support
- Behavioral change
- Good investment climate for market parties
- Respect for nature
- Sufficient workforce
- Appropriate laws and regulations
- Spatial integration
- Availability of raw materials
- Sufficient flexibility
- Required infrastructure

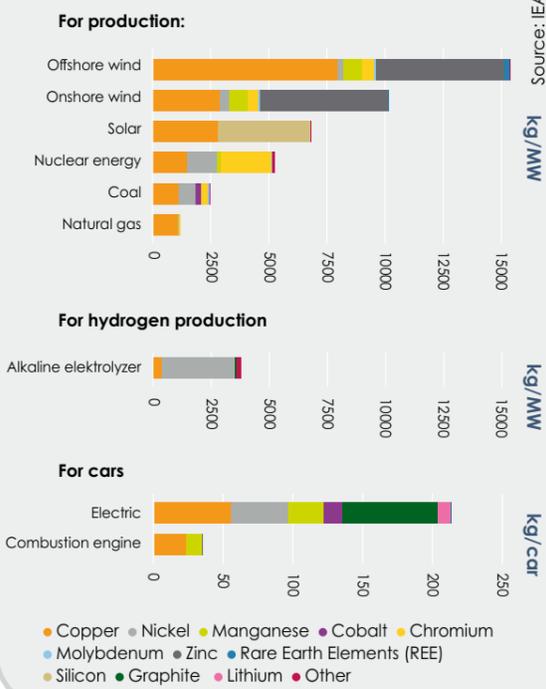
* Selection based on input from experts

Below we illustrate three conditions with facts and figures

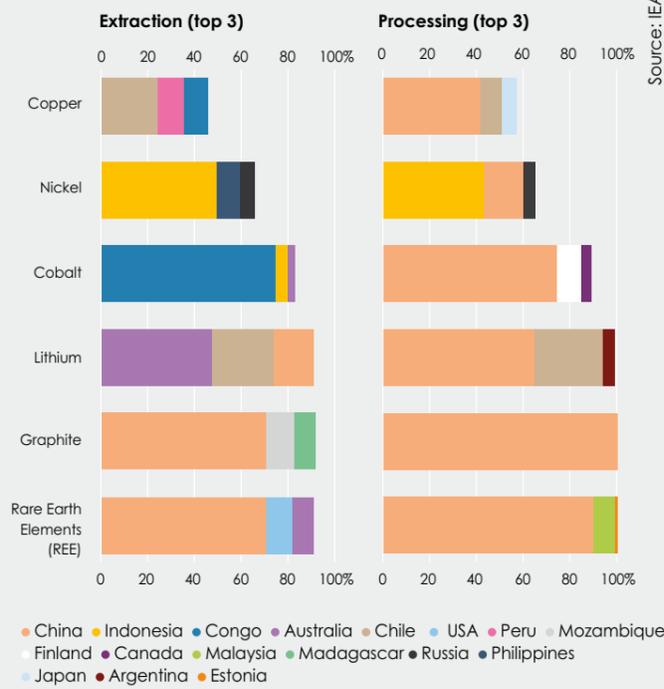


THE AVAILABILITY OF RAW MATERIAL

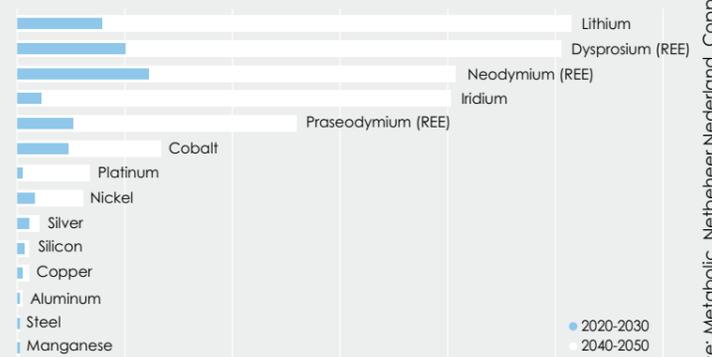
THE APPLICATION OF RAW MATERIALS



THE COUNTRIES IN WHICH RAW MATERIALS ARE EXTRACTED AND PROCESSED



THE DEMAND OF THE NETHERLANDS NOW AND IN THE FUTURE RELATIVE TO THE CURRENT GLOBAL PRODUCTION CAPACITY



GLOBAL DEMAND FOR RAW MATERIALS WILL INCREASE 4-6 TIMES BY 2040

WHAT ARE SOLUTIONS FOR THE RAW MATERIAL CHALLENGE?

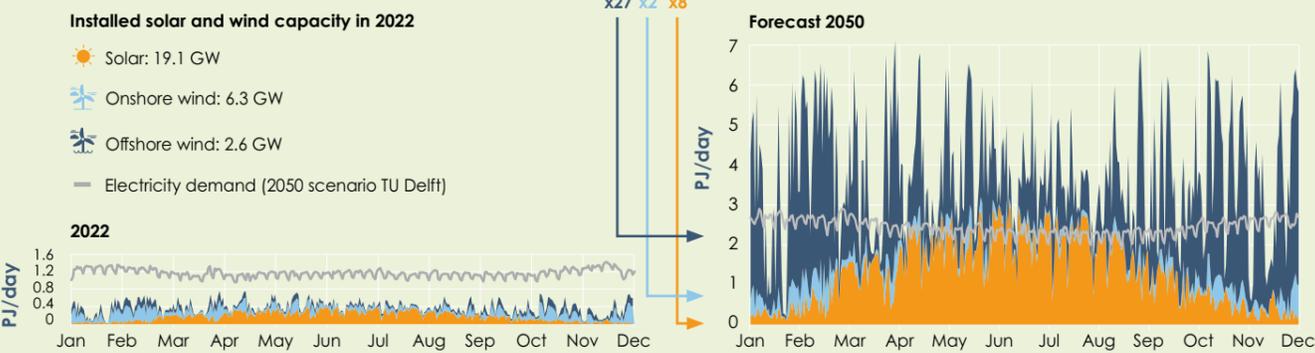
- Do not use
- Reuse
- Repair instead of replace
- Use of different materials
- Extract more



SUFFICIENT FLEXIBILITY

Source: Entrance (2022), TU Delft (2023), I13050 (2023)

VARIABILITY IN DEMAND AND GENERATION OF SUSTAINABLE ELECTRICITY

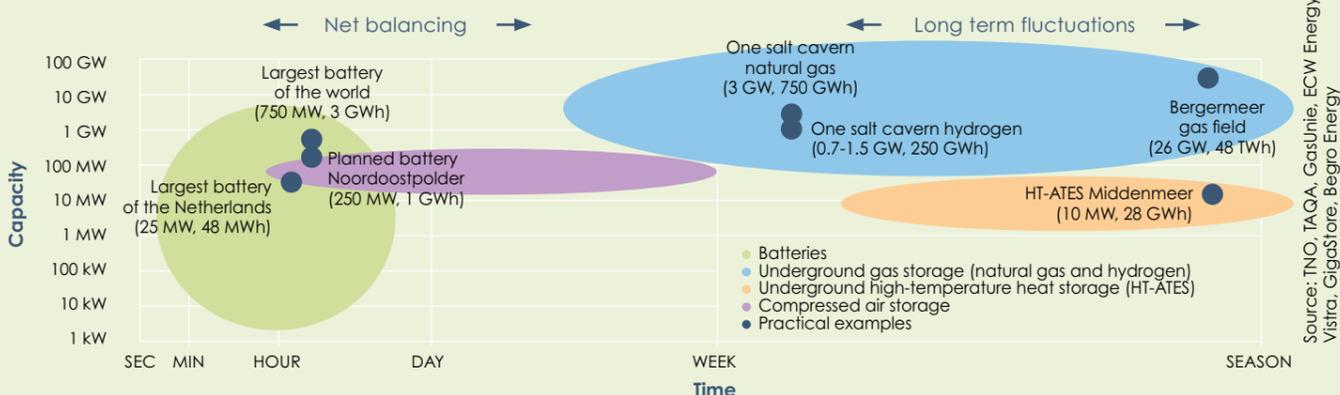


OPTIONS FOR FLEXIBILITY

- Adjustment of the demand profile**: For example: smart car charging, flexibility in the industry or electrolysis
- Adjustment of the supply profile**: For example: interconnectivity (import and export) and curtailment
- Storage**: Short term (electrons), Long term (molecules)
- Conversion to other energy carriers**: Heat, electricity, natural gas and hydrogen
- CO₂-free adjustable power**: Power stations on biomass, hydrogen or natural gas+CCS

THE MOST IMPORTANT STORAGE TECHNIQUES

EXPRESSED IN MAXIMUM CAPACITY, STORAGE VOLUME AND TIME



REQUIRED INFRASTRUCTURE

IN 2050

- Carbon**: 500-600 km CO₂ pipeline for approximately 500 Mton of stored CO₂
- Electricity**:
 - 320-510 km of additional overhead high-voltage cables
 - 80,000-105,000 km of additional buried electricity cable for low- and medium voltage*
 - ~50% extra transformer houses in neighbourhoods*
 - From 9 to 19-29 GW interconnection capacity with neighbouring countries
 - Approximately 4500 km of electricity cables at sea and 8-16 extra converter stations on the coast*
- Hydrogen**:
 - 1800-2000 km of hydrogen pipeline, of which ~70% reused gas pipelines
 - 300-400 km of offshore hydrogen pipeline, possibly reused gas pipelines
 - 15-60 salt caverns and possibly some gas fields for large-scale hydrogen storage
- Heat**:
 - From 500,000 to 2.5-3 million households connected to district heating

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