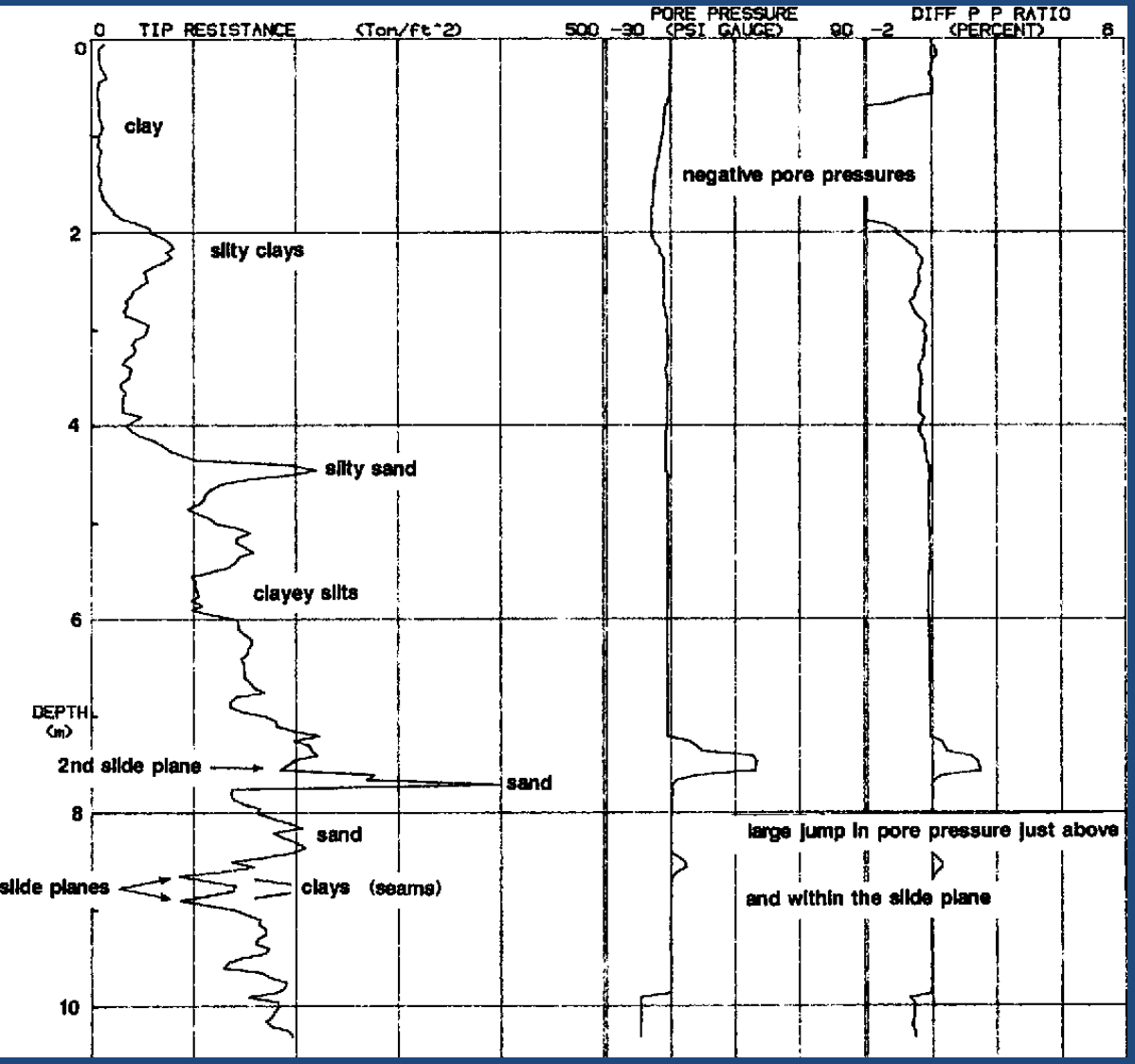


Ministry of Economic Affairs and Climate Policy

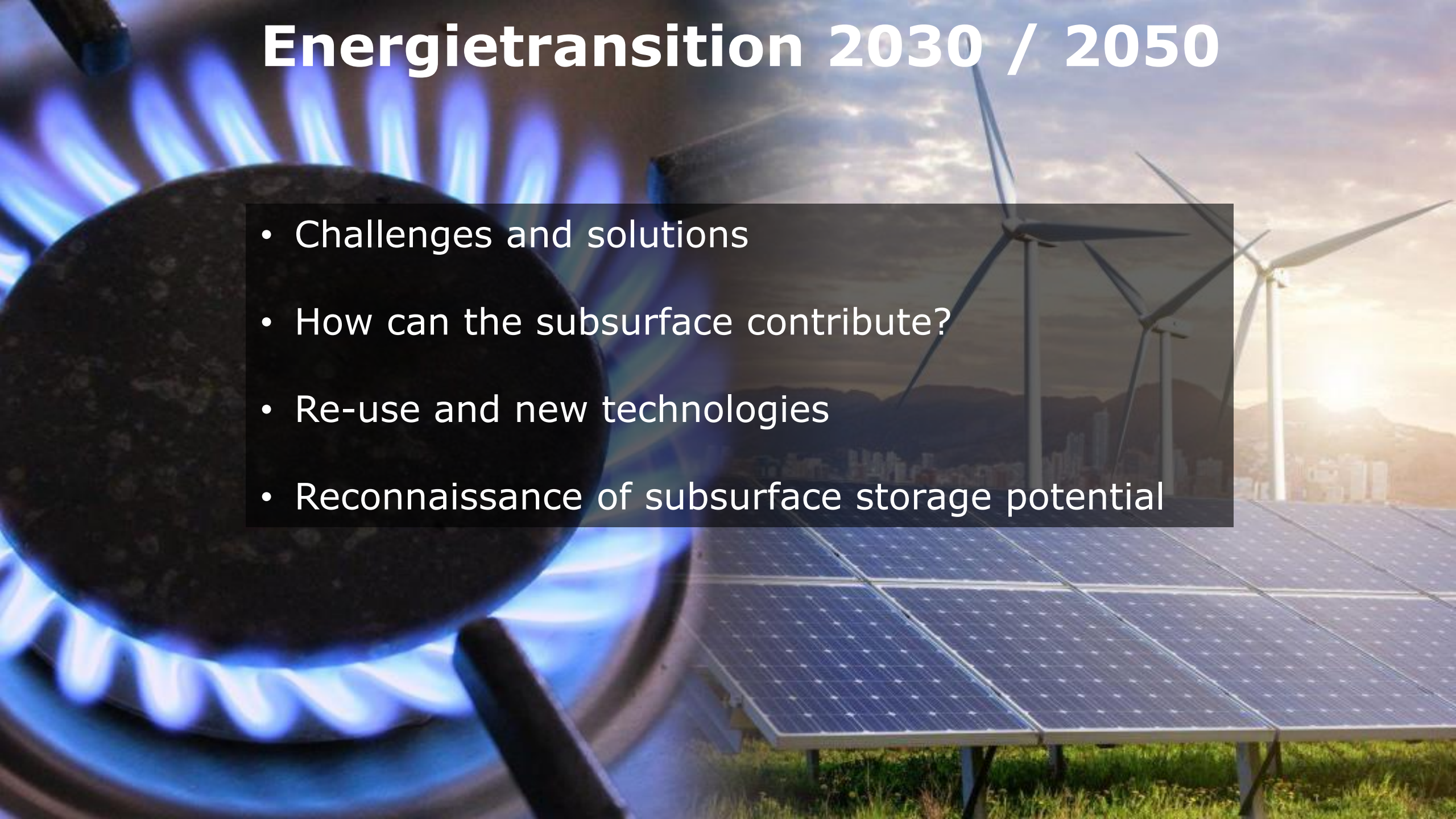
Energy in transition

The subsurface at our service

Issues for today

1. Is there a role for the subsurface in the Energy transition?
2. What is that role?
3. What are the social challenges using the subsurface in that new role

Energietransition 2030 / 2050



- Challenges and solutions
- How can the subsurface contribute?
- Re-use and new technologies
- Reconnaissance of subsurface storage potential

Climate goal = CO_2 reduction

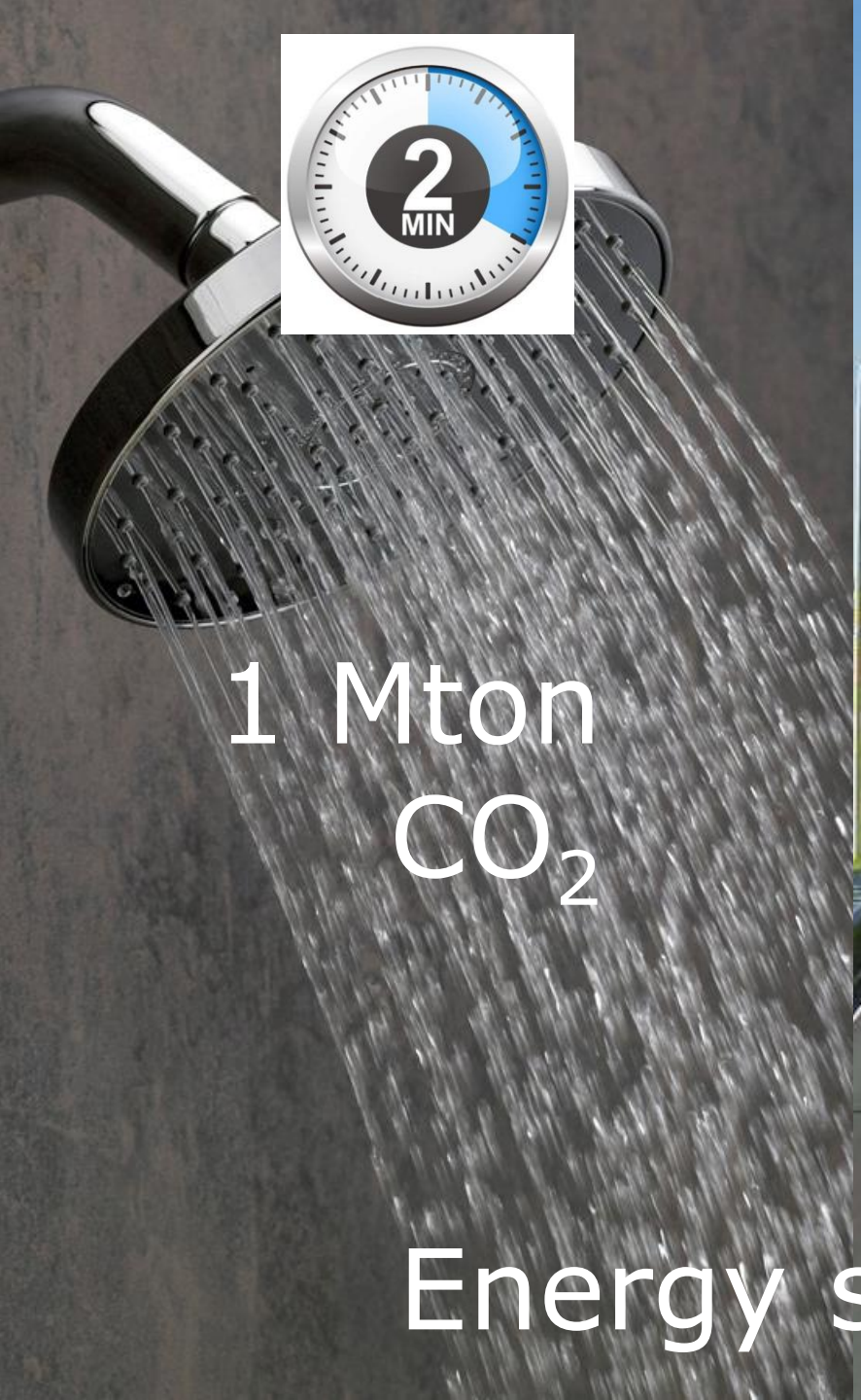
Foto bron: www.agro-chemie.nl

Reduction of Green house gas emissions

- Energy saving en energy efficiëncy
- CO_2 capture and storage
- CO_2-free sources and technologies

Energy saving

Role of subsurface



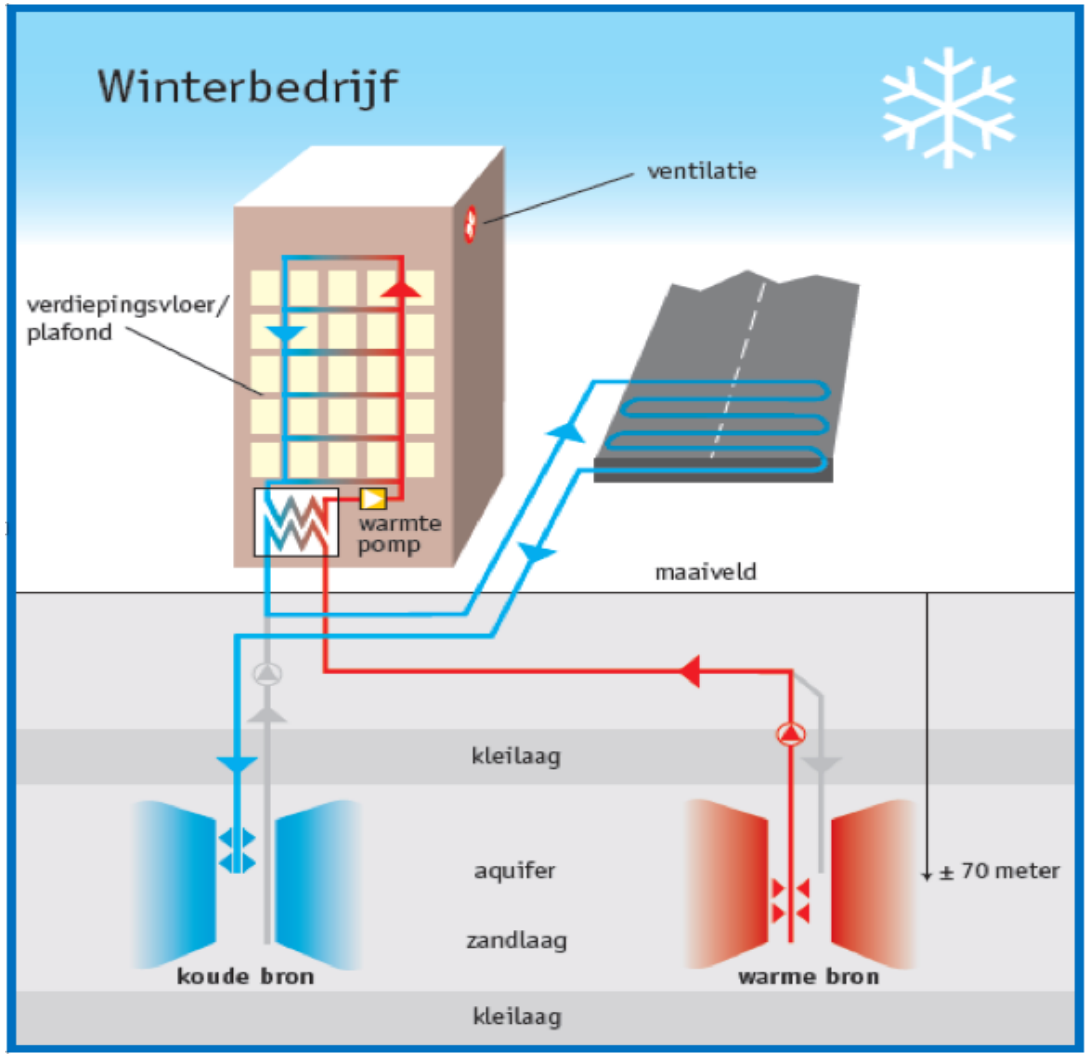
1 Mton
CO_2

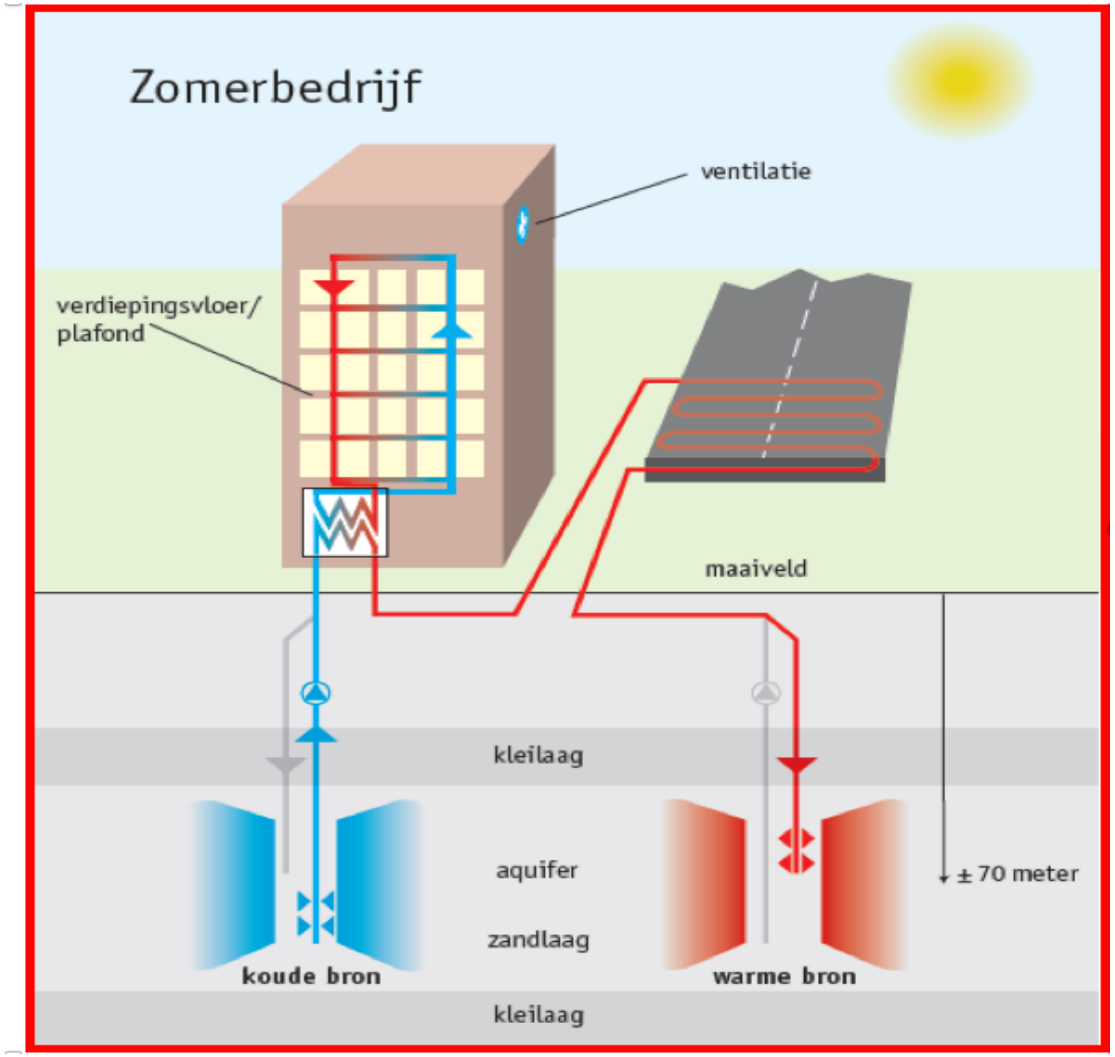
1,5 Mton
CO_2

0,8 Mton
CO_2

Energy savings by adaptation

Subsurface energy saving





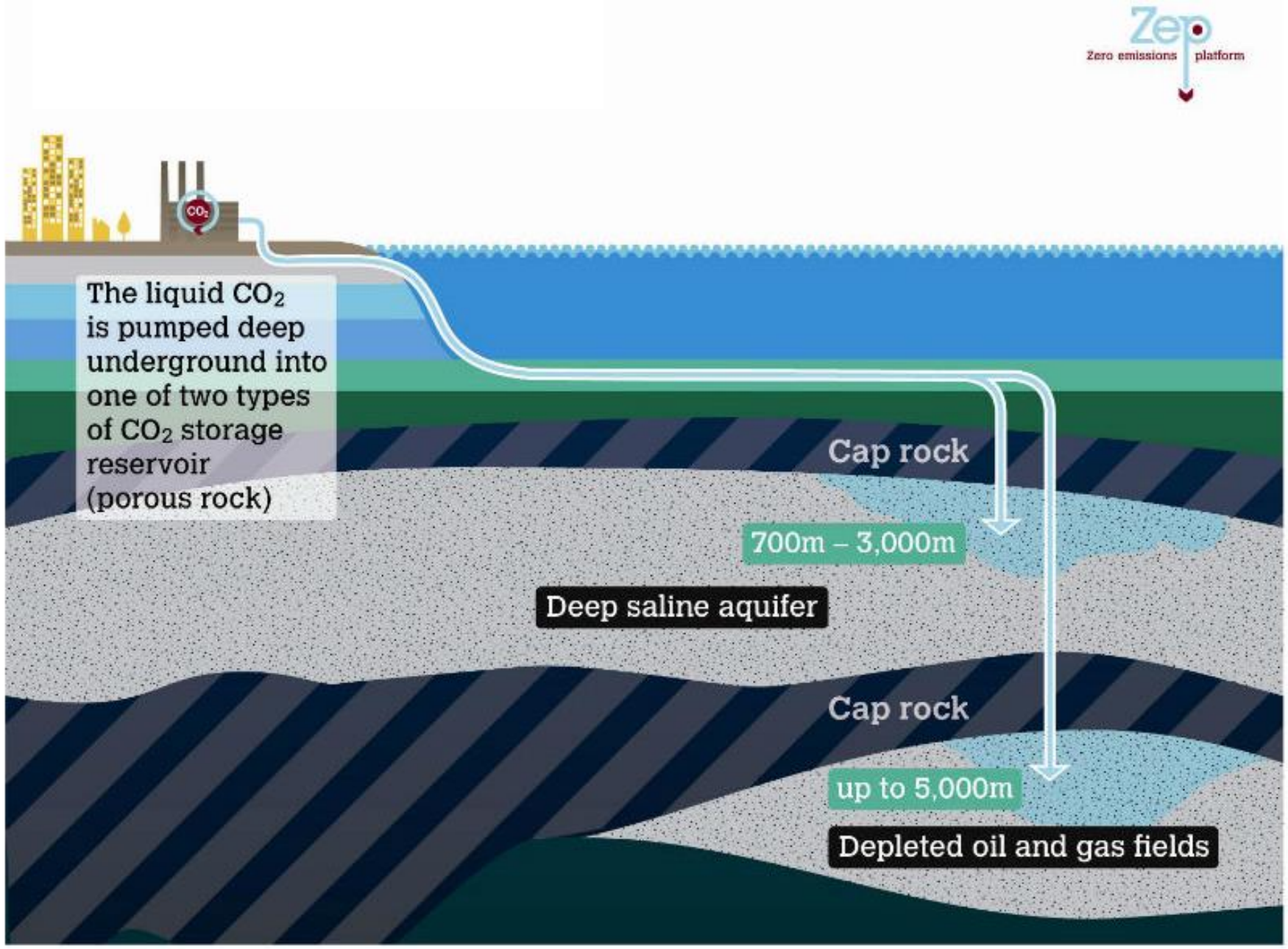
Aquifer Thermal Energy Storage

www.duurzaaminvesteren.nl

CO2 Storage

Role of subsurface

CO2 capture and storage



Sustainable sources

Role of subsurface

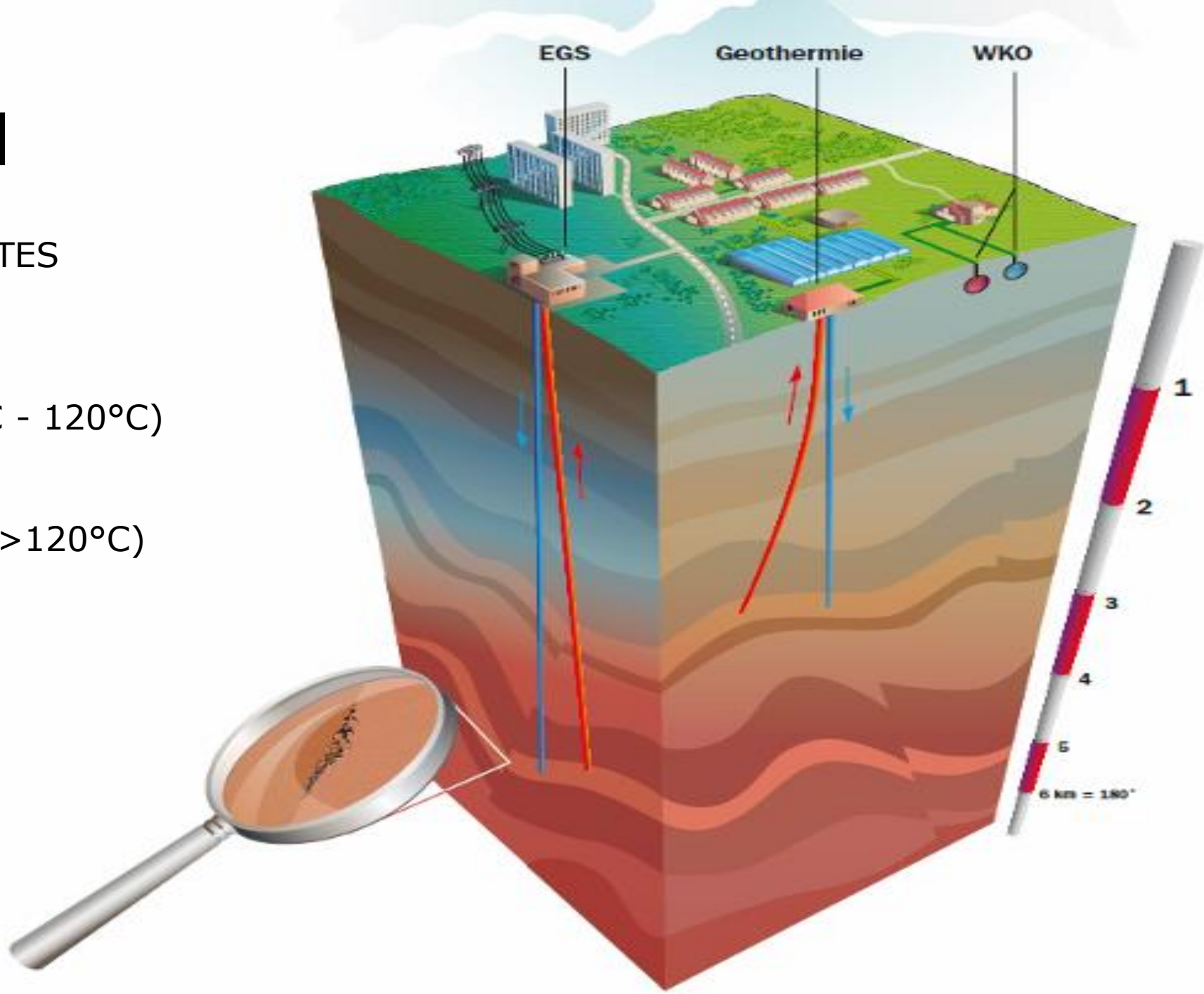
CO2 free energy sources and technologies

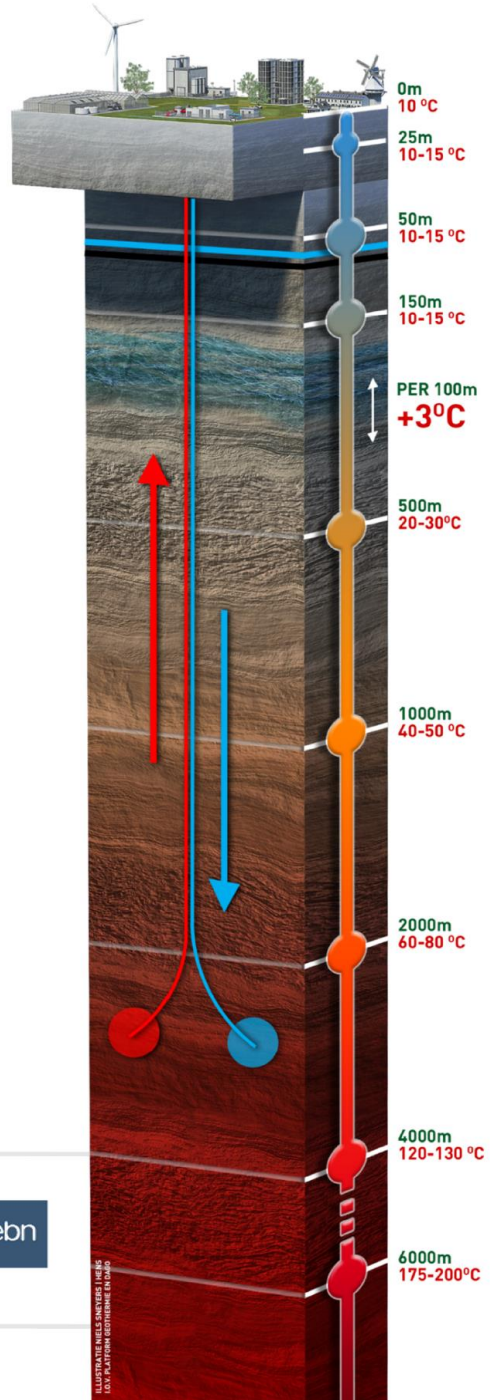
Geothermal

Shallow systems and ATES
Till approx. 100 m

Deep geothermal
1.000 – 4.000 m (40°C - 120°C)

Ultra-deep geothermal
Deeper than 4.000 m (>120°C)





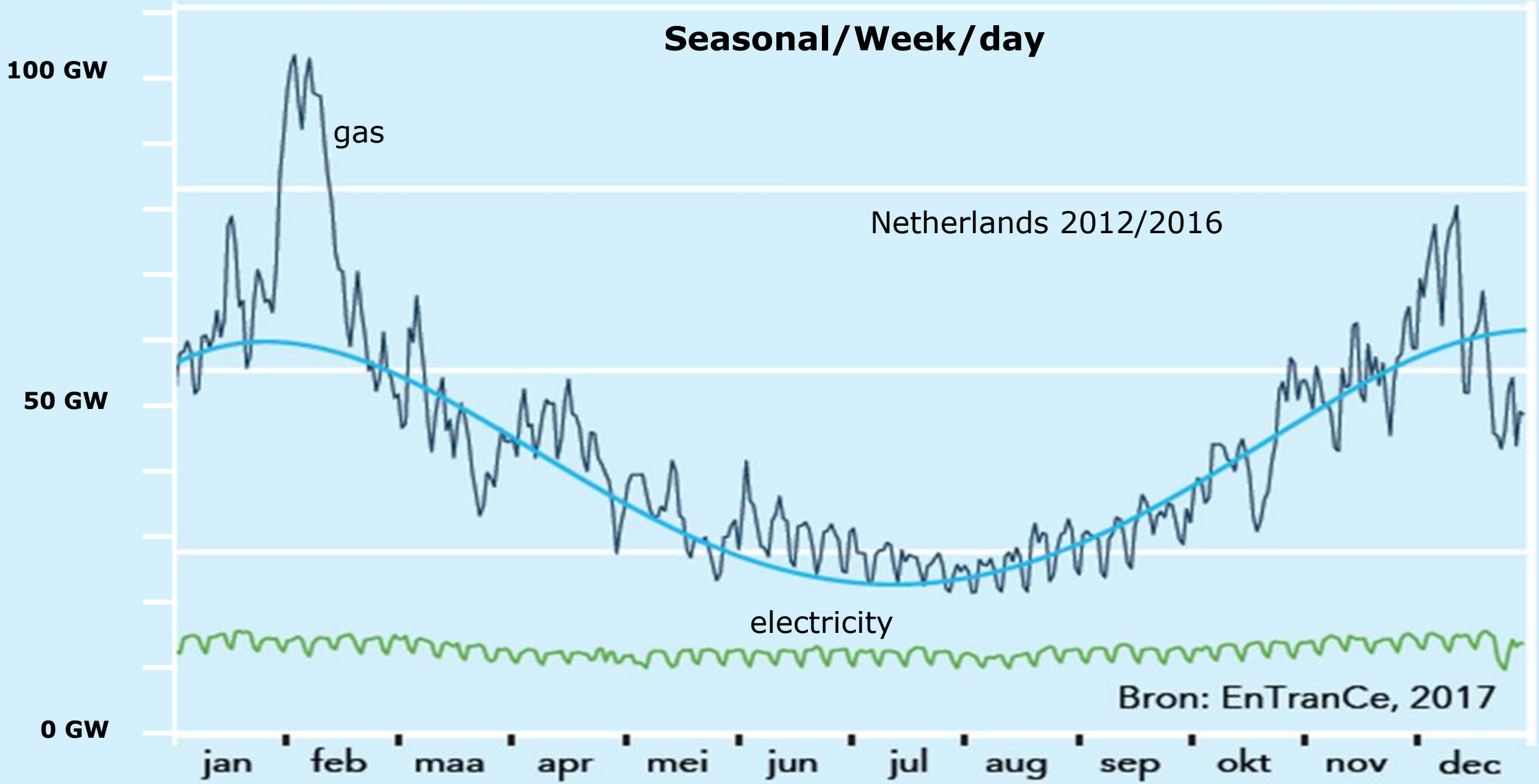
	2018	2025	2030	2050
Nr of doublets	17 1-2 nieuwe per jaar	75 10 nieuwe per jaar	175 20 nieuwe per jaar	700 25 nieuwe per jaar
Nr of houses connected	0	140k 5 PJ	570k 20 PJ	3,8m 135 PJ
Spatial claim	10 17 soccerfields	50 Efteling	110 Volendam	450 Centrum Rotterdam
Employability	240	1320	2400	3400
direct[1]	70	380	700	1000
indirect[2]	170	940	1700	2400

1 Banen in de markt; exclusief extra FTE bij overheid niet meegenomen 2 Indirecte FTE's zijn support functies, adviseurs, leveranciers, etc.; ~2.5 indirecte FTE per directe FTE aangenomen

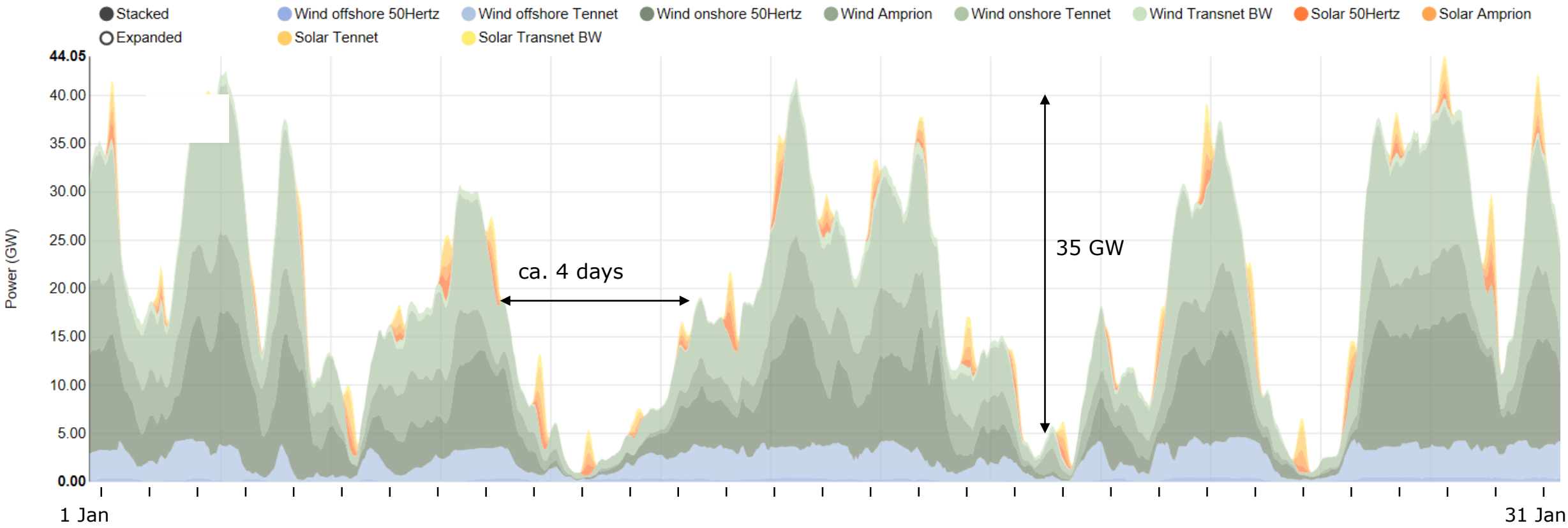
Sustainable energy and security of supply

Role of subsurface

Variable energy demand



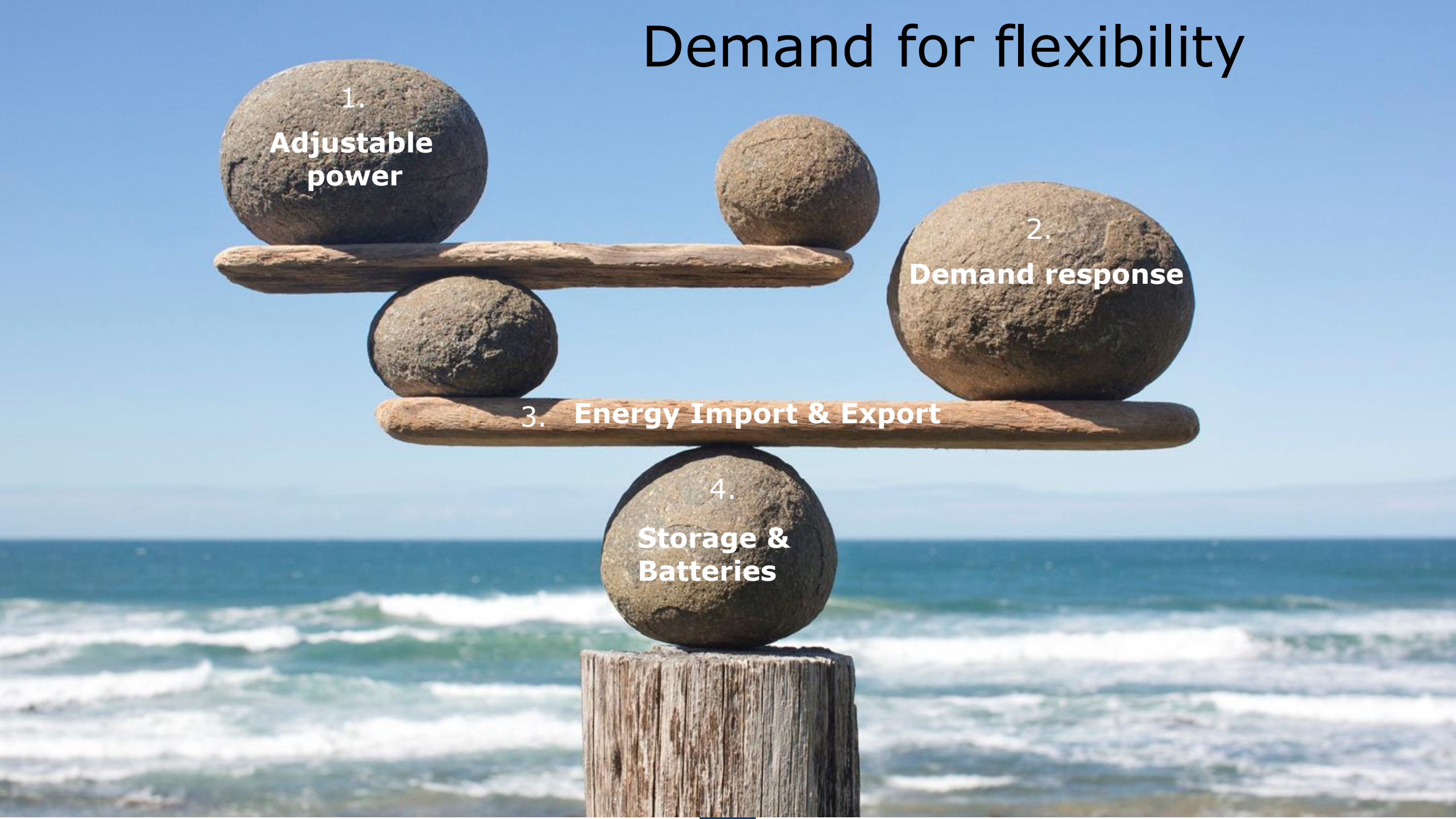
Future: variable energy supply (renewables)



Renewable electricity production, Germany, January 2018
(Ca. 40 – 50 GW wind and solar)

EnergyCharts.de

Demand for flexibility



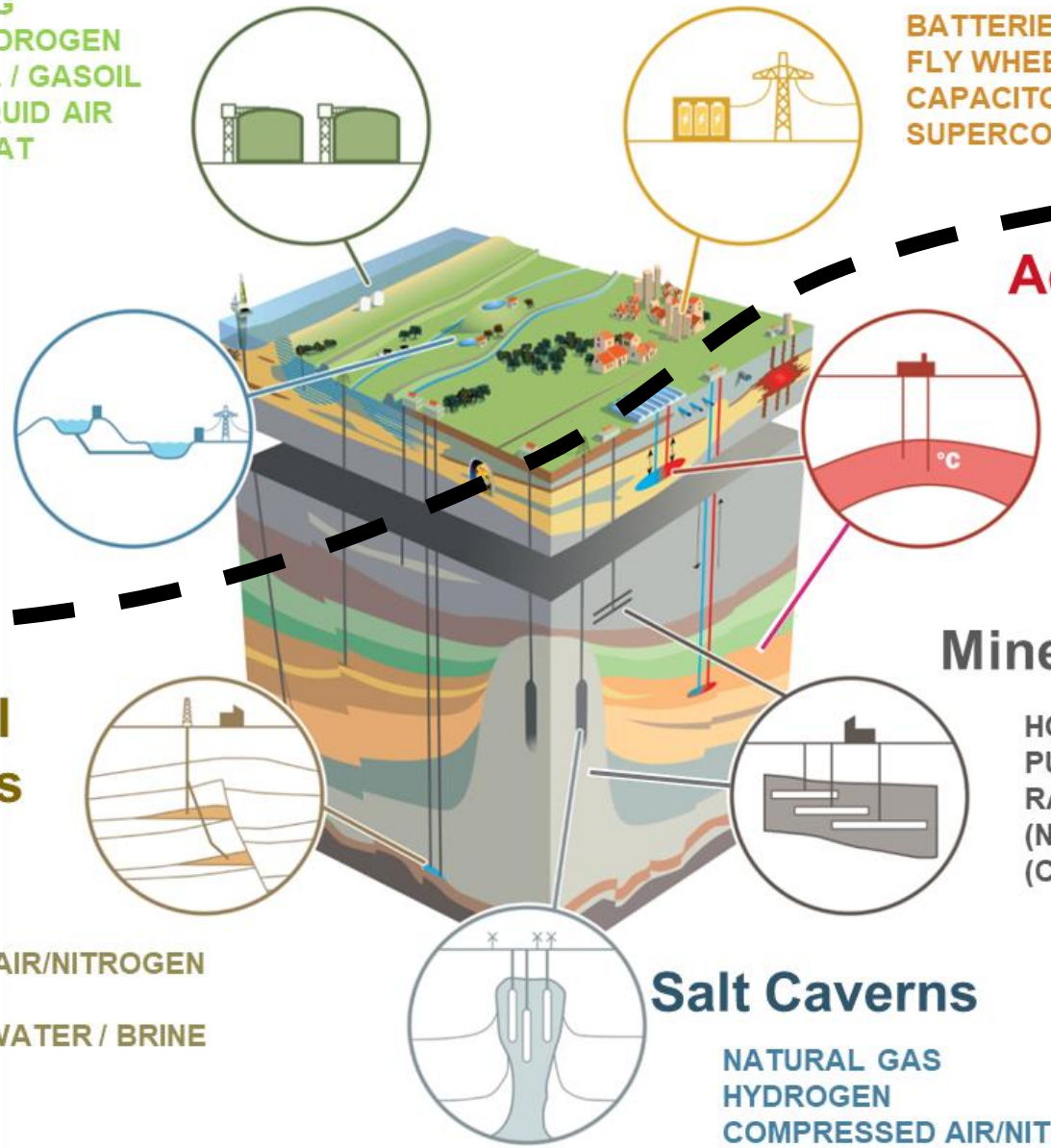
Flexibility from storage

Storage tanks

LNG
HYDROGEN
OIL / GASOIL
LIQUID AIR
HEAT

Surface Electrical

BATTERIES (DIVERSE SOORTEN)
FLY WHEELS
CAPACITORS
SUPERCONDUCTIVE MAGNETS



(Elevated*) Lakes Island Basins

PUMP ACCUMULATION
(SURFACE WATER)

Aquifers

HOT/COLD WATER
NATURAL GAS
HYDROGEN
COMPRESSED AIR/NITROGEN
CO2
BRINE

Mines, Tunnels, Cavities

HOT/COLD WATER
PUMP ACCUMULATION (WATER/BRINE)
RADIOACTIVE & OTHER WASTE
(NATURAL GAS *)
(COMPRESSED AIR/NITROGEN *)

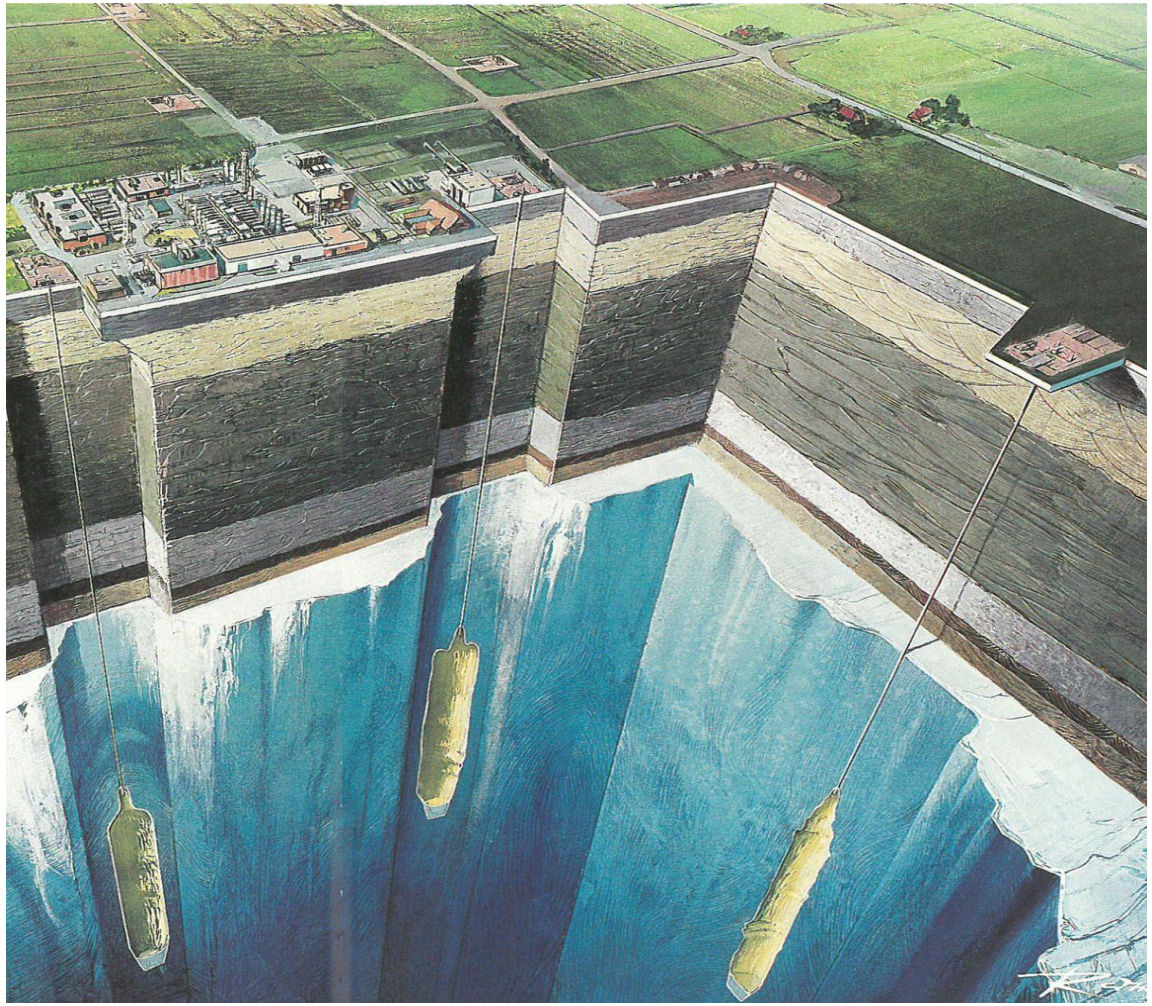
Depleted Oil & Gas Fields

NATURAL GAS
HYDROGEN
STIKSTOF
COMPRESSED AIR/NITROGEN
CO2
PRODUCTION WATER / BRINE

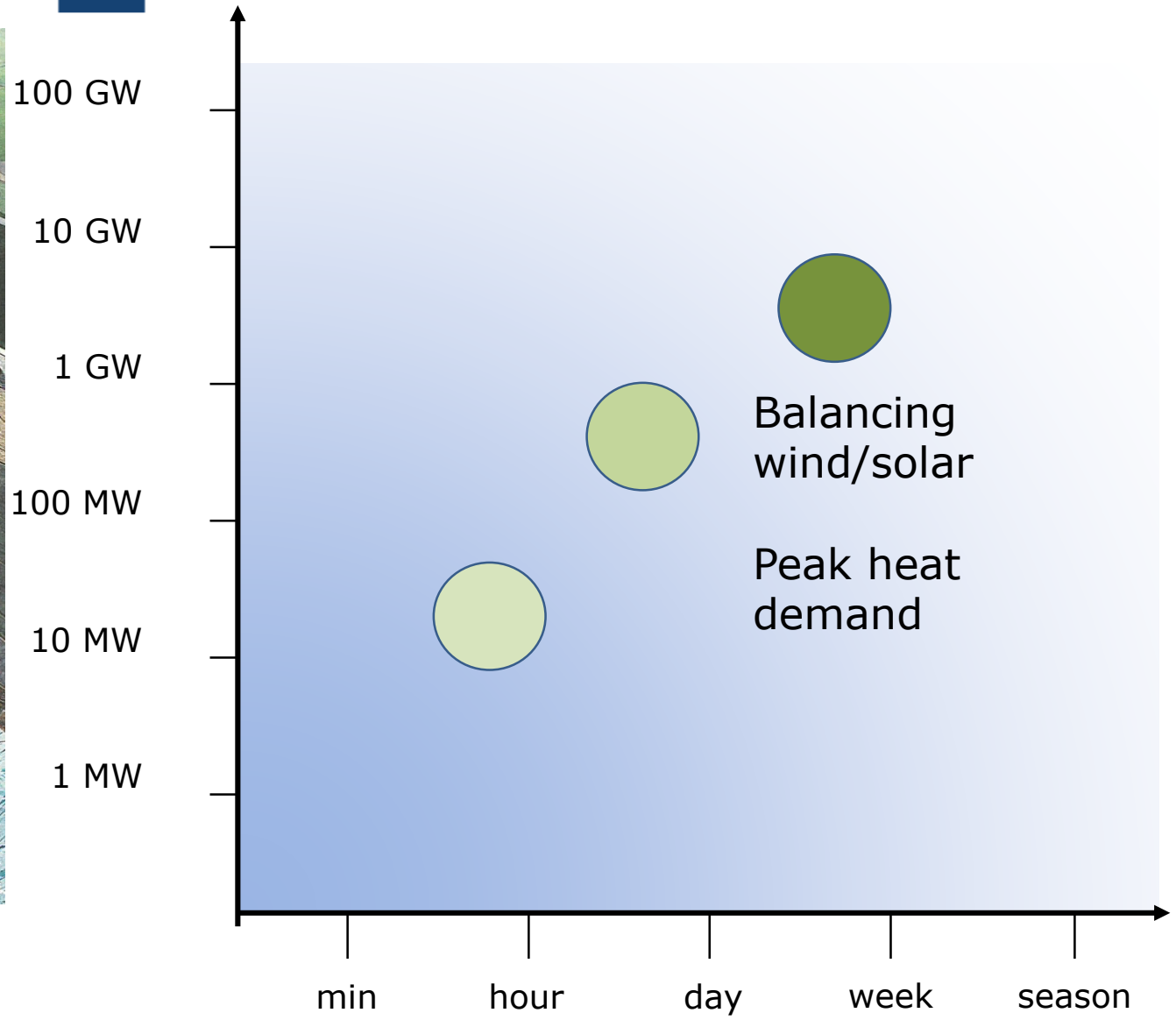
Salt Caverns

NATURAL GAS
HYDROGEN
COMPRESSED AIR/NITROGEN
GASOIL
BRINE
HELIUM

Salt caverns

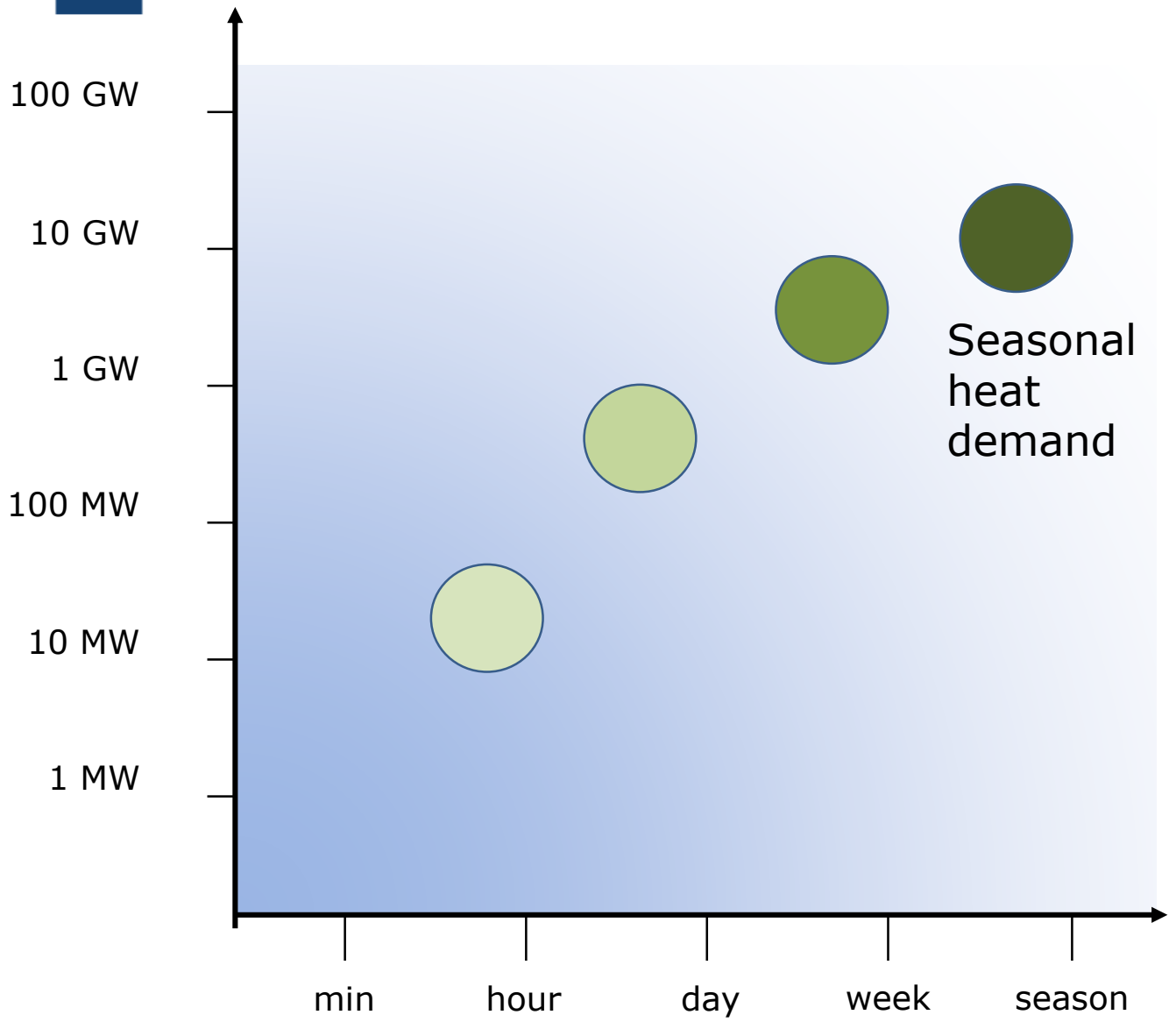


Natural gas: ca. 3-4 GW
Hydrogen: ca. 1 GW
ca. 1 – 2 weeks



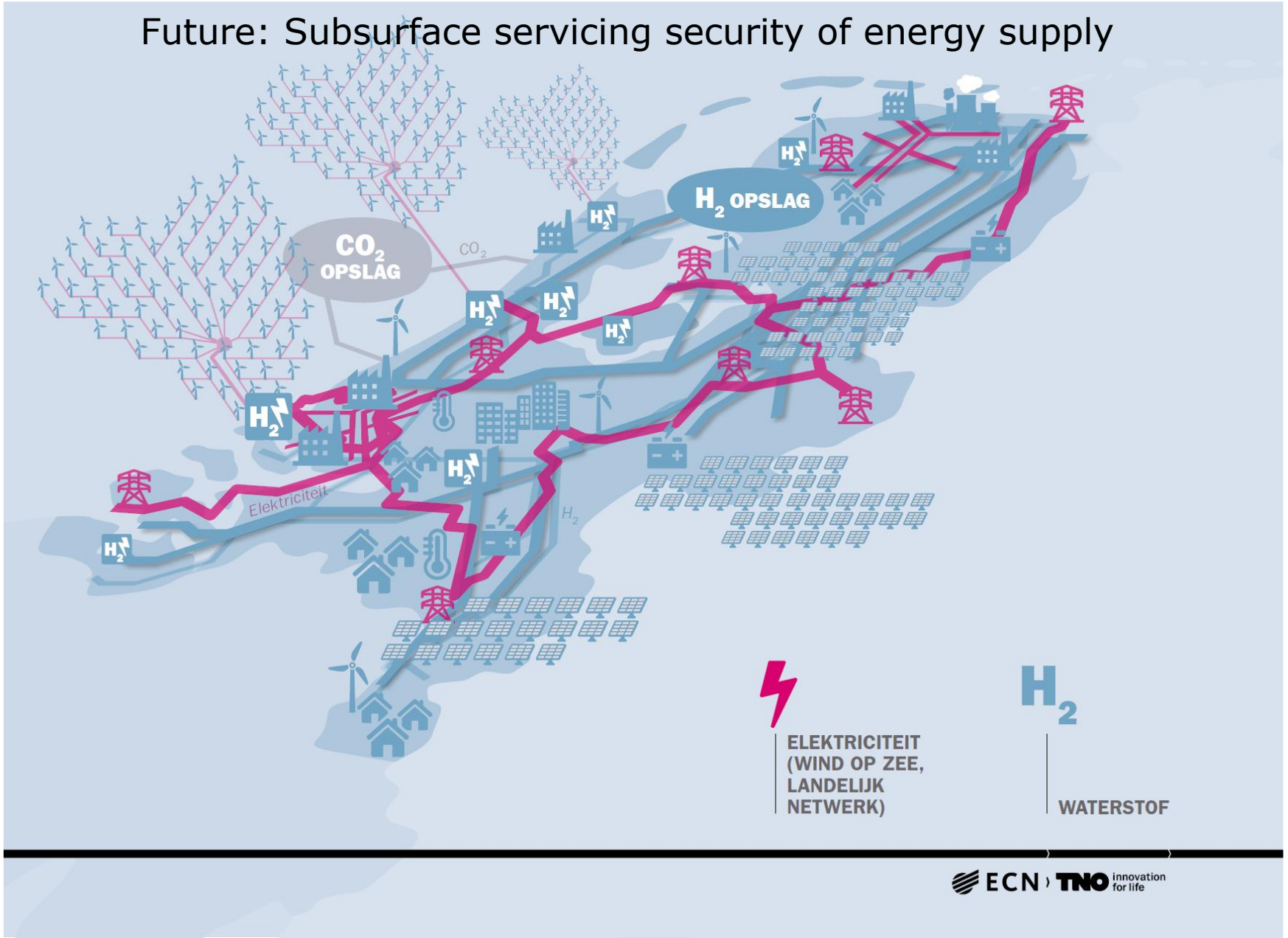
Example storage 1 day wind: 3-4 caverns (H_2)

Gas fields

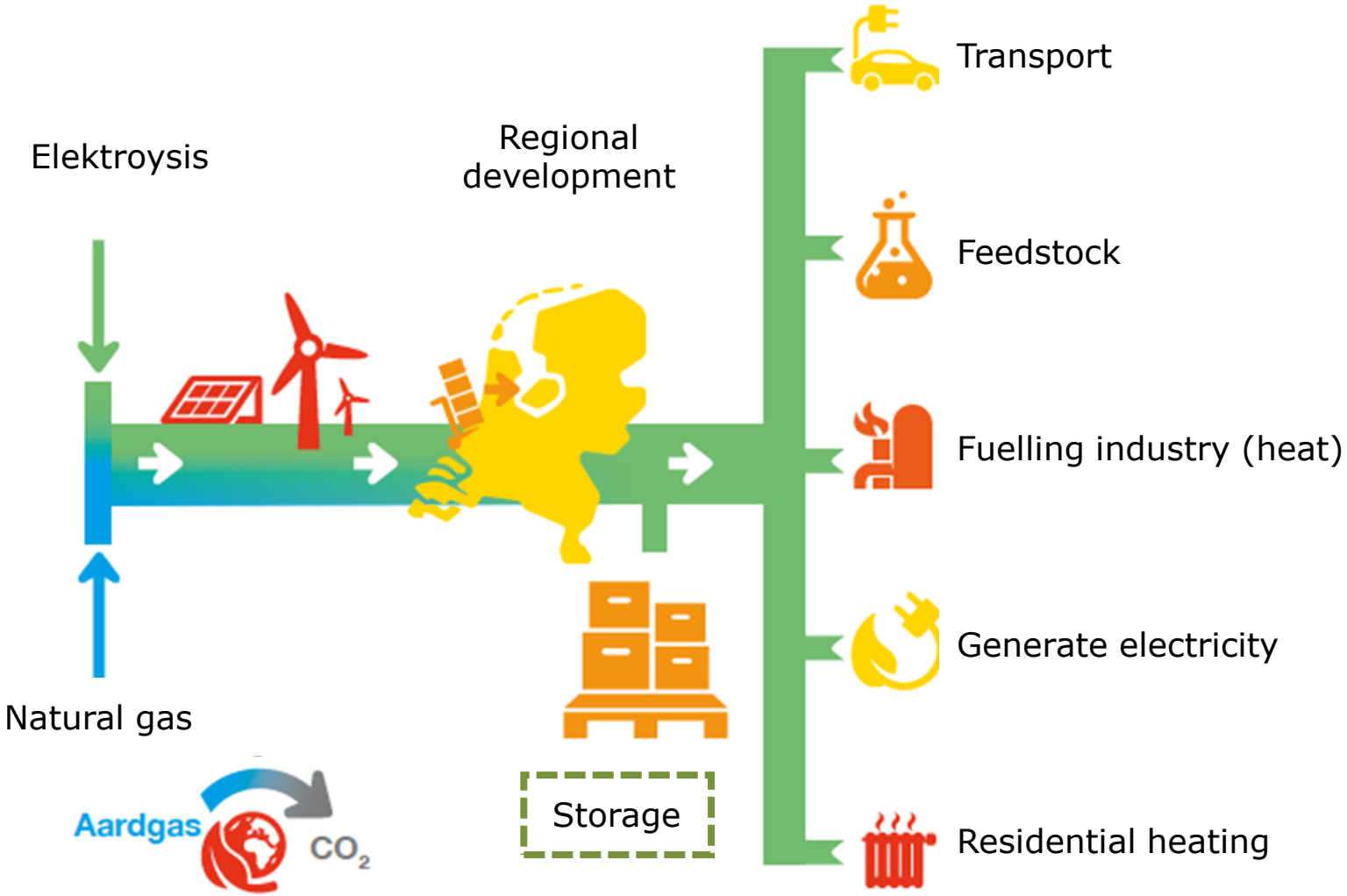


Natural gas: ca. 10 – 30GW
Hydrogen: ca. 3 – 10 GW
ca. 50 – 100 days

Future: Subsurface servicing security of energy supply

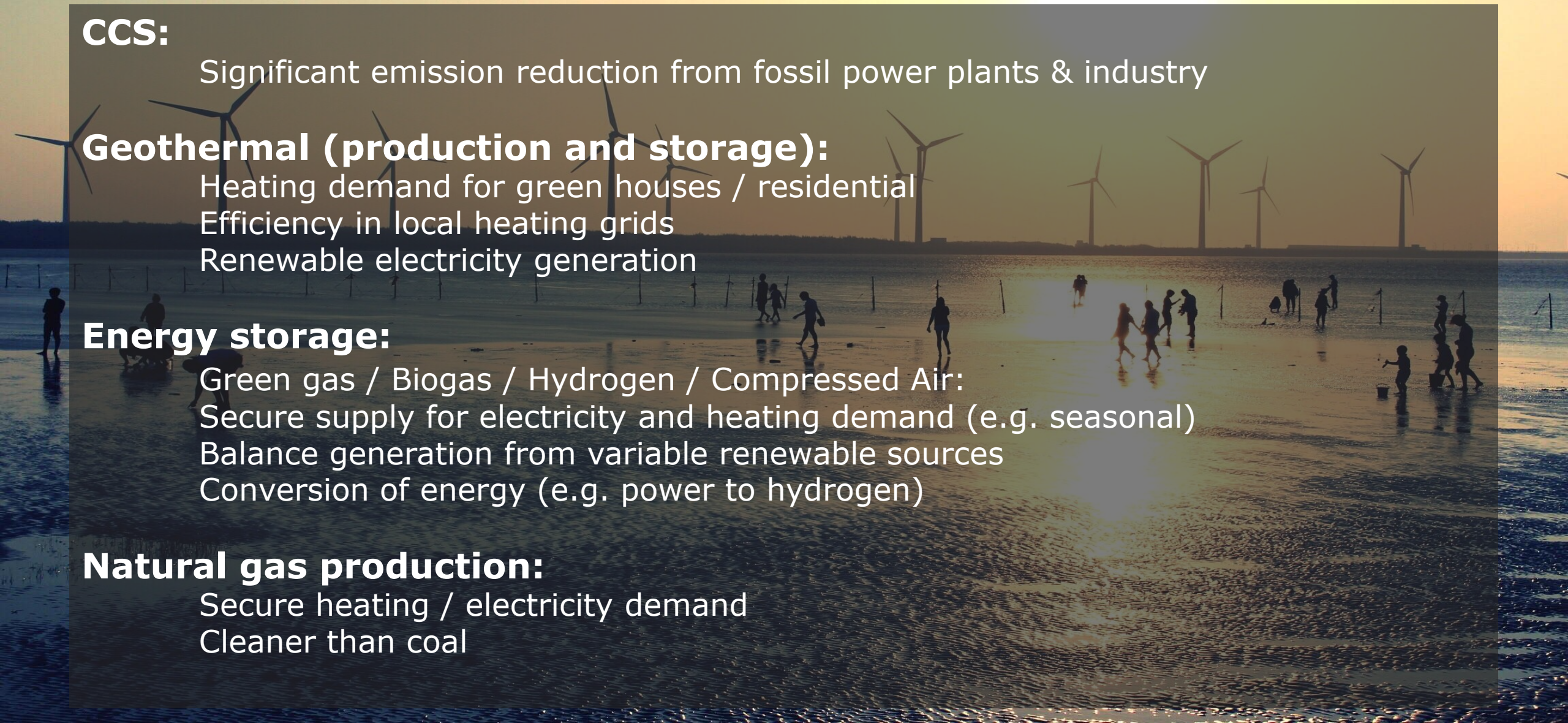


Hydrogen



Routekaart waterstof (2018)

Climate goals and renewables
Clean, secure and affordable energy



CCS:

Significant emission reduction from fossil power plants & industry

Geothermal (production and storage):

Heating demand for green houses / residential
Efficiency in local heating grids
Renewable electricity generation

Energy storage:

Green gas / Biogas / Hydrogen / Compressed Air:
Secure supply for electricity and heating demand (e.g. seasonal)
Balance generation from variable renewable sources
Conversion of energy (e.g. power to hydrogen)

Natural gas production:

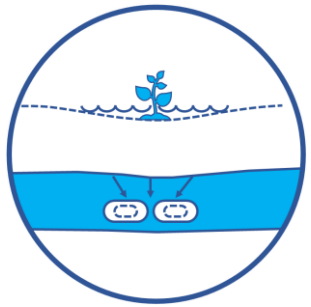
Secure heating / electricity demand
Cleaner than coal

Safety and public acceptance

Seismicity

Are there critically stressed faults?
What are the impacts of seismic events?

Subsidence and collapse



What are the effects of developing many salt caverns?
What are the long term impacts?

Leakage and migration

Is the containment of hydrogen guaranteed?
Is there a risk of leakage along the wells?

Facility risks

What are the surface risks (e.g. explosions)?
Where can it safely be deployed?


WHAT THE FRACK?


SchaliegasNEE!
Liever boeren dan boren!


BERGEN GASBOM VRIJ!
GAS
RAMP


CO2
OVER DE DIJK
ERMEE !!!


WEG MET HET GAS!
DA'S
NOGAL WIEBES!

The new reality

Symbols and perception stronger than facts

Scientific reports loosing value in public debate

The transition

Traditional role

Future role


Thank you for your attention