Kansen en uitdagingen in de energietransitie

02 April 2025 |

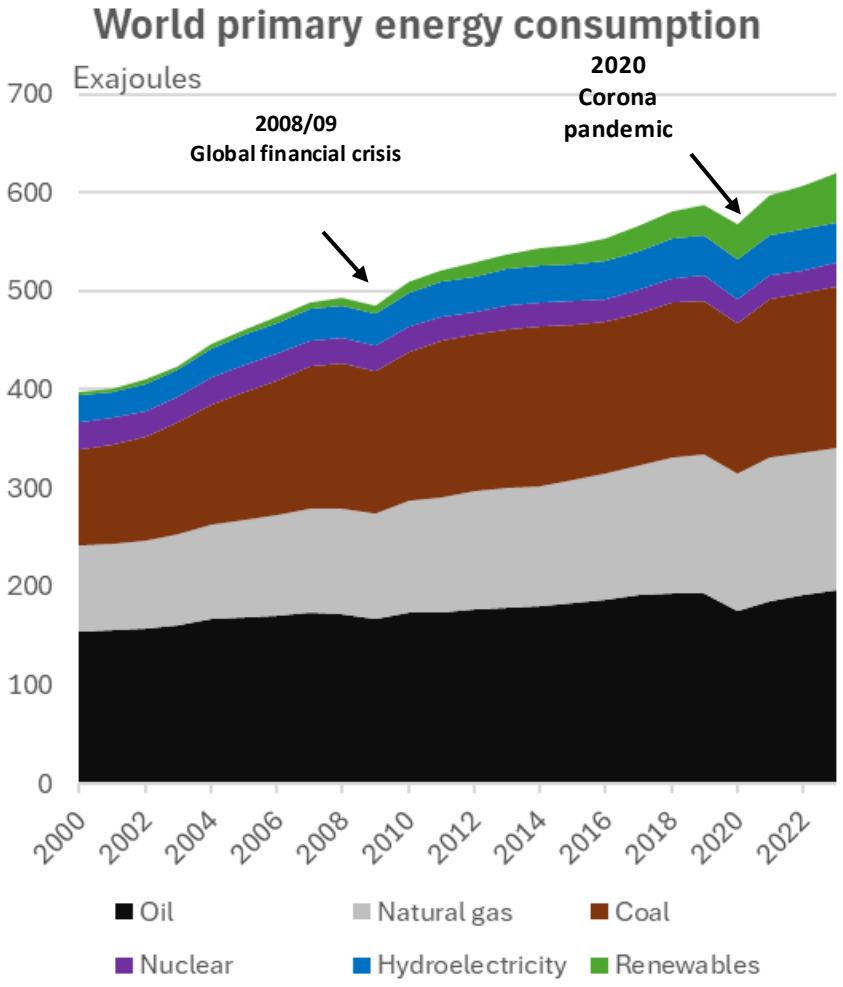
Dr. Mark Boneschanscher, managing director

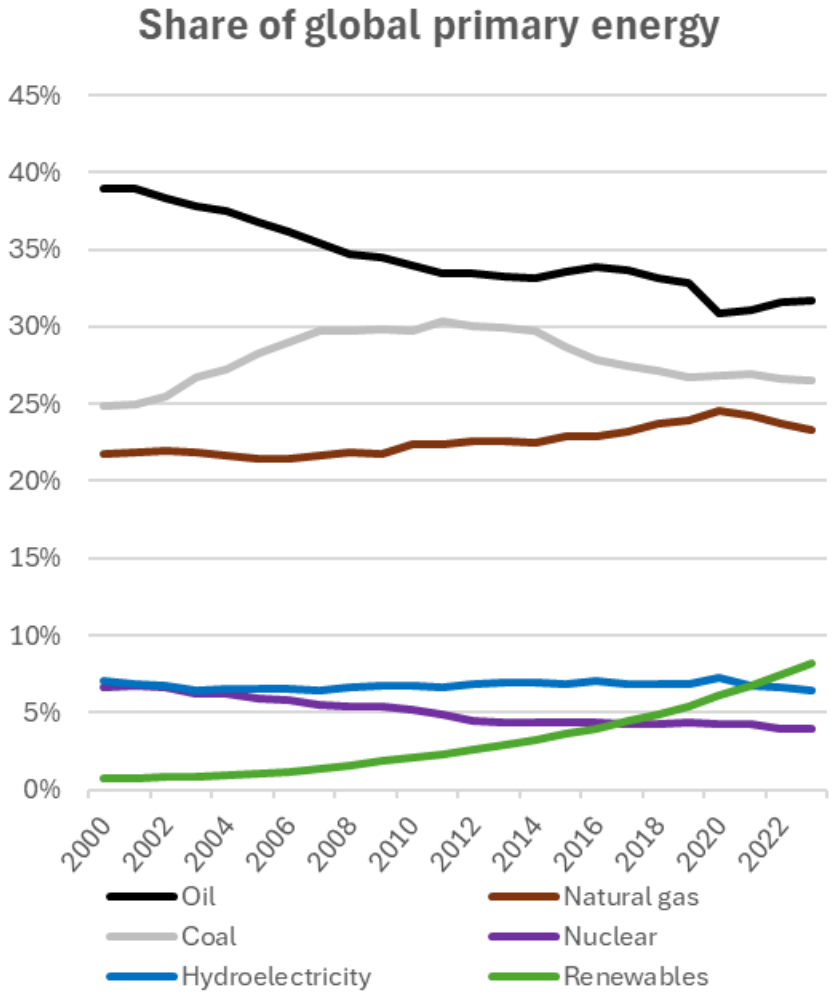
Layout

- The energy transition: where do we stand?
- Towards a future energy system: dot on the horizon
- Consumer dynamics, modular scaling, and the ET
- Considerations regarding ET technology development
- Wrap up & conclusions

The energy transition: where do we stand?

The energy transition: where do we stand?



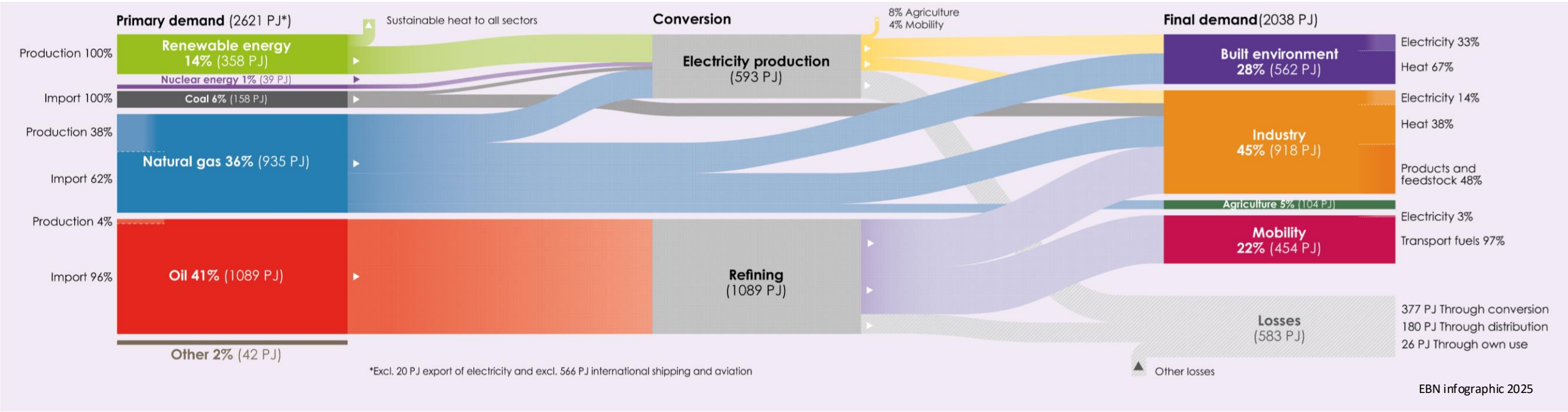


Energy Institute
Statistical Review
of World Energy 2024

1 Exajoule = 1000 PJ = 278 TWh
= 163 Mboe = 28.4 Gm^3 NG

1 PJ can supply a city like Tilburg with electricity for a year

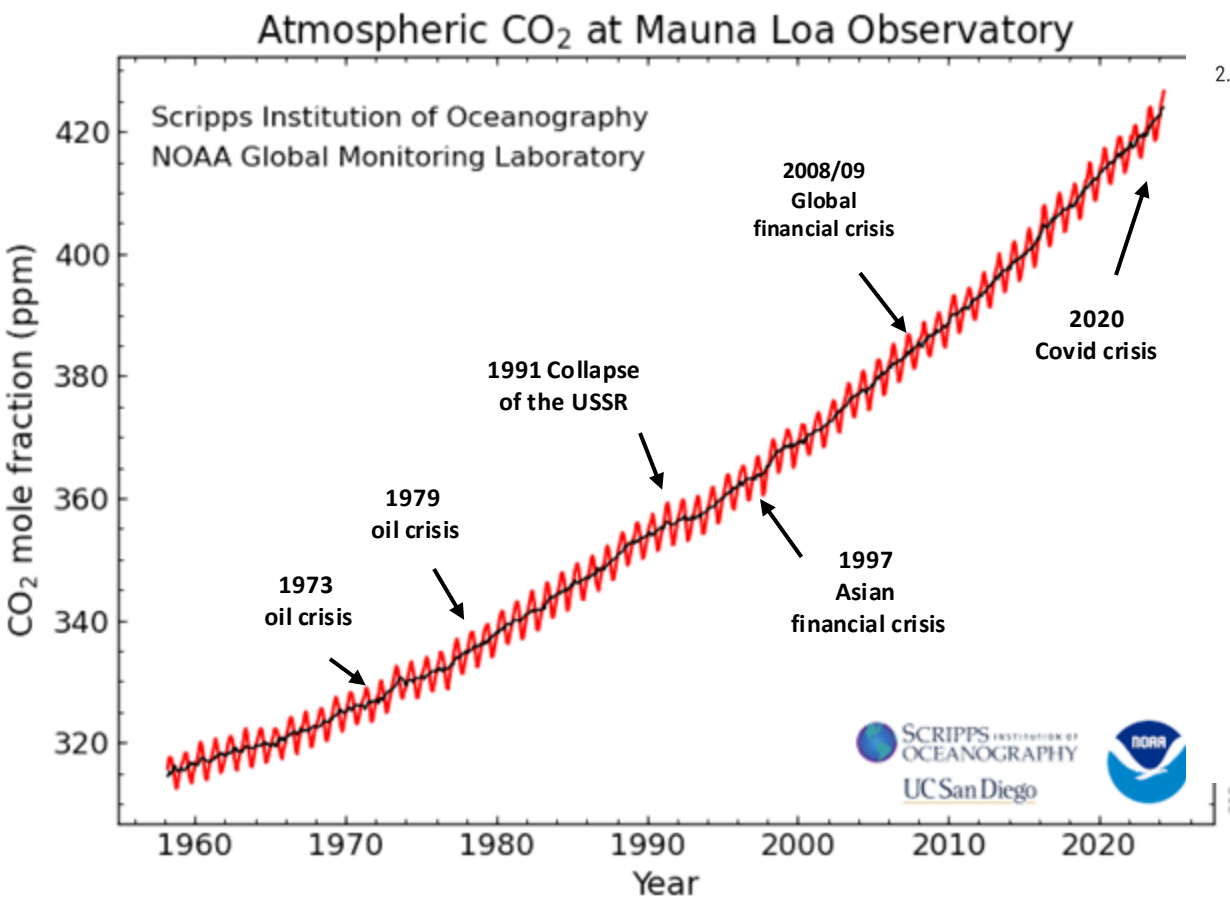
The Dutch energy system as example: from source to consumption



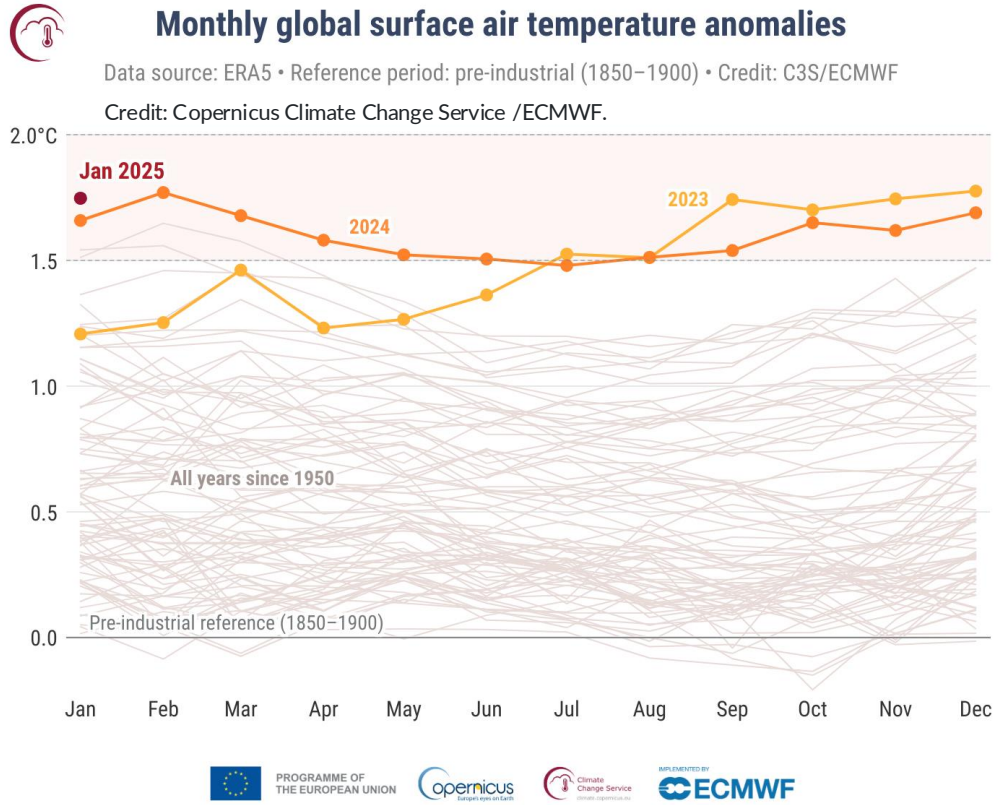
EBN infographic 2025

- NL energy system as representation of 'typical' developed economy, but heavy on gas and process industry due to Groningen
- Key point 1: we have >20% conversion losses in our energy system
- Key point 2: Industry consumes ~45% of all energy, mainly in the form of feedstocks and heat
- Key point 3: built environment is a driving force for integration of renewables ('consumer electronics': PV, heatpumps, batteries)

The consequence



www.esrl.noaa.gov

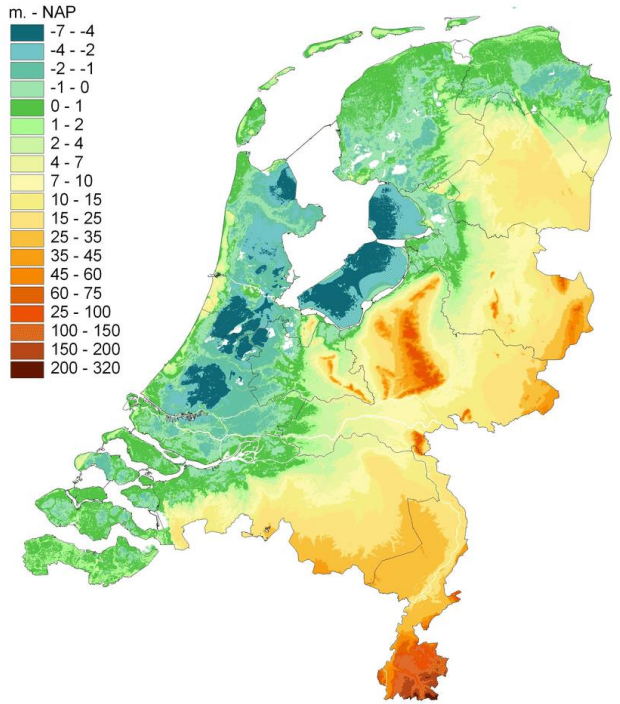


According to Samantha Burgess, Strategic Lead for Climate at ECMWF:

"January 2025 is another surprising month, continuing the record temperatures observed throughout the last two years, despite the development of La Niña conditions in the tropical Pacific and their temporary cooling effect on global temperatures. Copernicus will continue to closely monitor ocean temperatures and their influence on our evolving climate throughout 2025."

Why we should care

Google earth

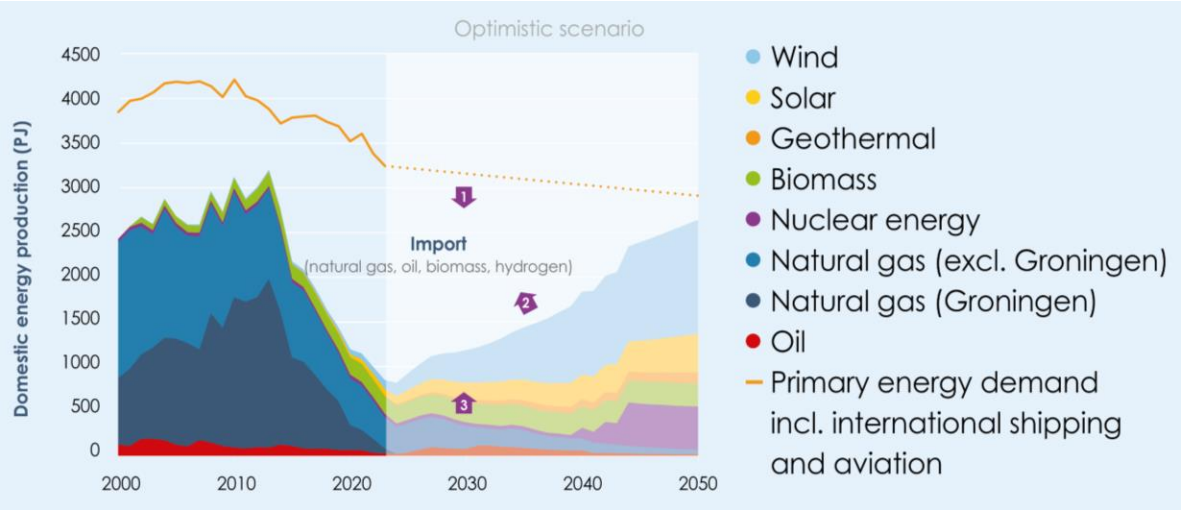


M. Blom-Zandstra et al., doi:10.1088/1755-1315/8/1/012018

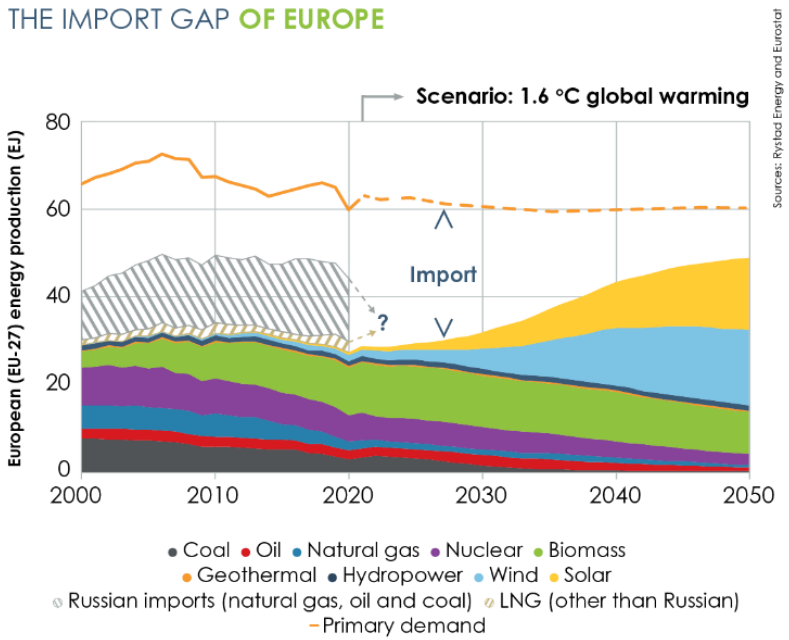
© Sam Jones / The Guardian – 30 October 2024
At least 95 people have died in eastern, central and southern Spain after torrential rains triggered the country's deadliest floods in three decades, unleashing torrents of muddy water that surged through cities, towns and villages, trapping people in their homes, bringing down trees, and cutting off roads and railway lines.

Russian invasion as terrible wake-up call

- EU and NL are not self-sufficient, our options:
  - Reduce energy demand
  - Increase renewable energy production
  - Increase energy import (complicated due to geopolitics)
  - Slow down decline of fossil energy production (undesired)



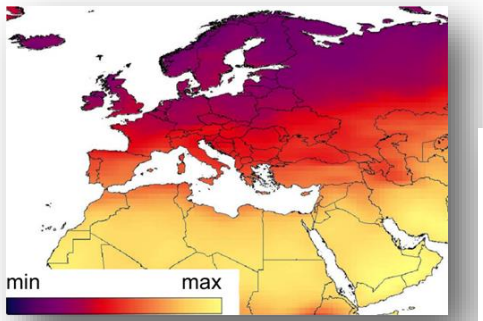
EBN 2025

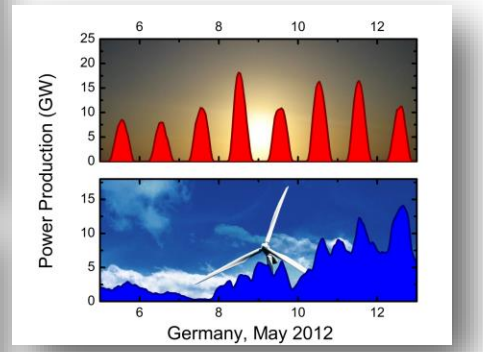


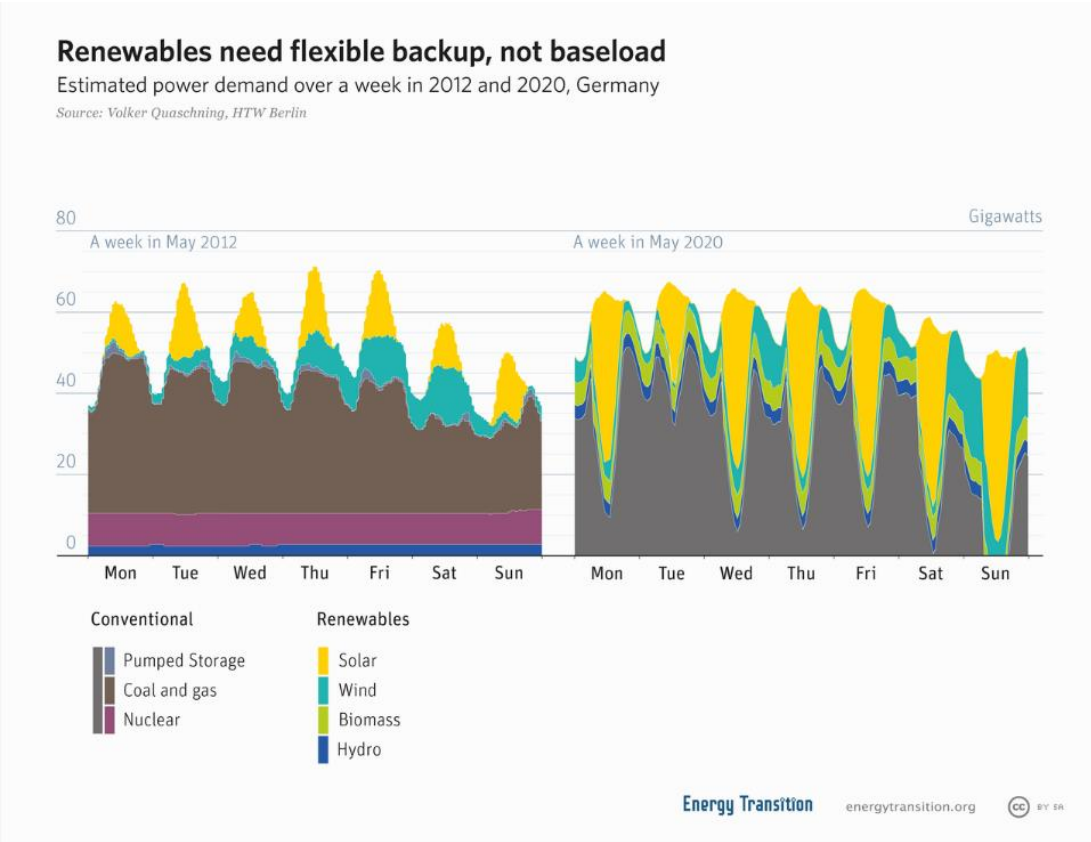
Towards a future energy system: dot on the horizon

Renewable energy brings its own challenges

Supply and demand: mismatch in time and place



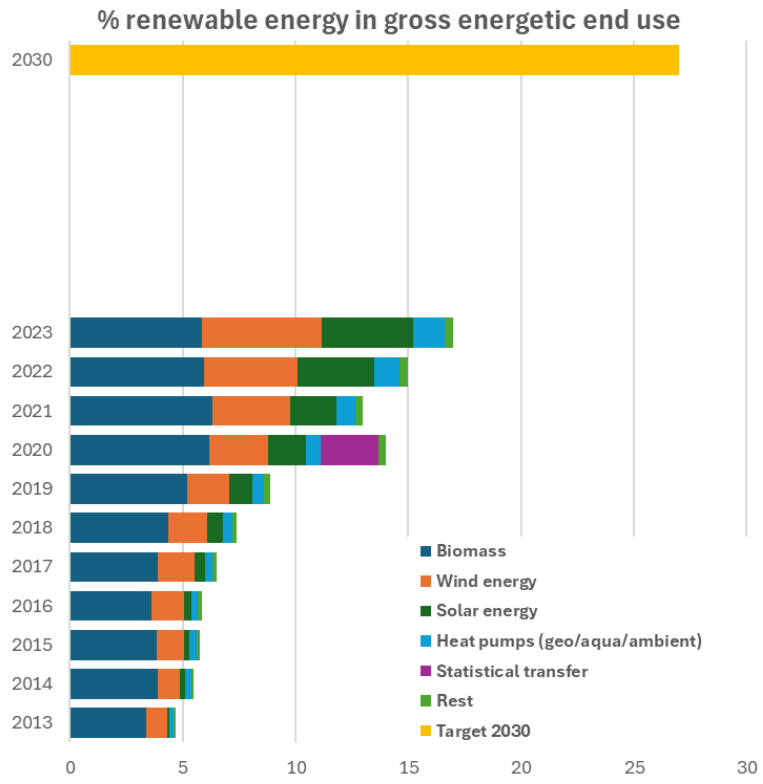




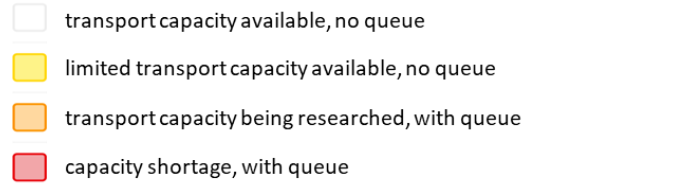
Key challenge: transport + conversion + storage of energy (= system integration)

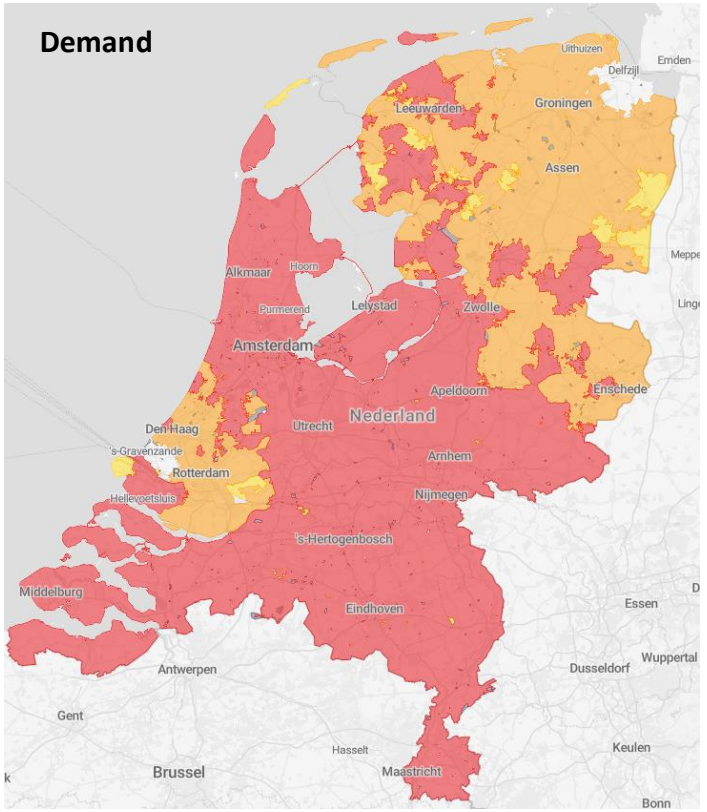
Current infrastructure is not prepared

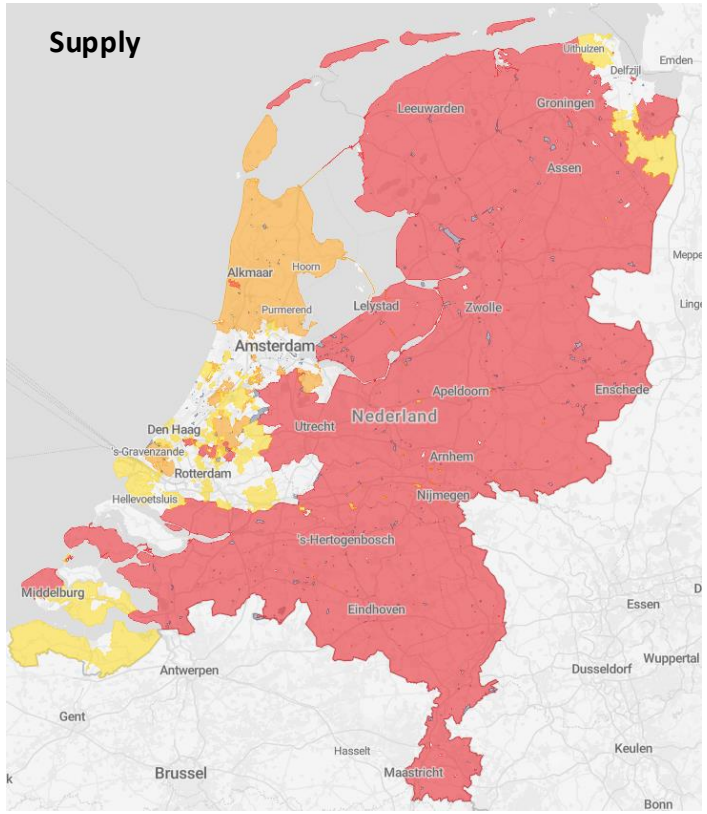
Rapid increase solar, wind, and electrification of end use



CBS 2024

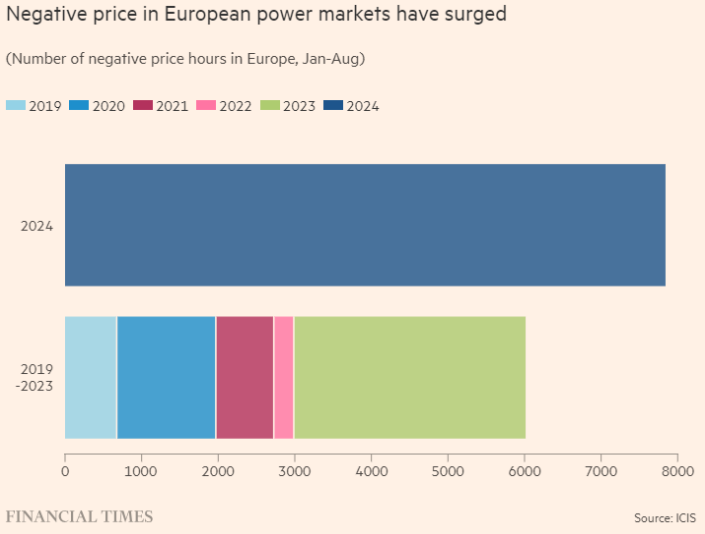


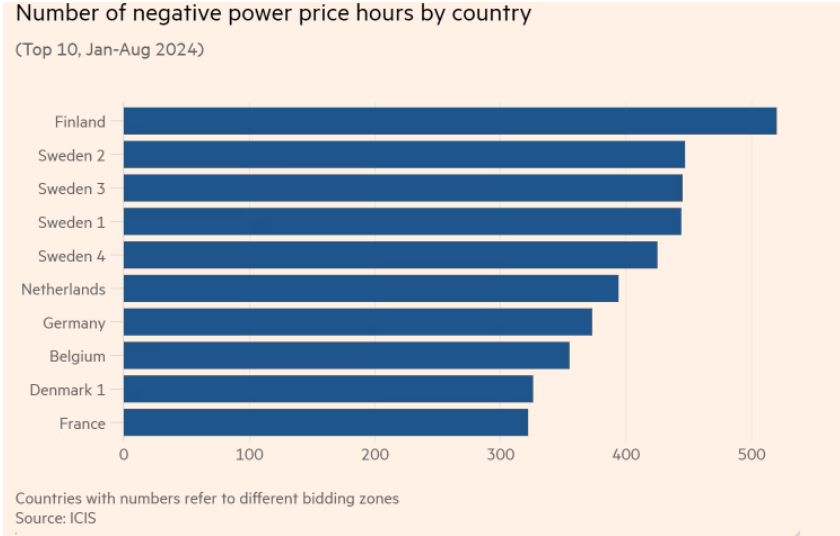




Netbeheer Nederland, February 2025

Economic consequences





- Price cannibalization may deter investments and slow the energy transition.
- It is therefore key that the uptake of renewables is accompanied by adequate investments in grids, flexibility and storage.

'Draghi report' – EU competitiveness: looking ahead, 9 September 2024

- Delaying the implementation of measures to support integration could jeopardize up to **15% of solar PV and wind power generation in 2030** and would likely result in **up to a 20% smaller reduction of carbon dioxide (CO2) emissions in the power sector**.

IEA report Integrating Solar and Wind, 18 September 2024

Economic consequences

De Telegraaf NIEUWS LIVE SPORT ENTERTAINMENT FINANCIEEL VROUW LIFESTYLE WAT U ZEGT

NIEUWS / BINNENLAND

Het beste van De Telegraaf

Lees voor

'Ambtenaren vielen van stoel'

Boven op de hoge energierekening: 'Bedrag van 195 miljard euro nodig voor oplossen overvol stroomnetwerk'

Door LEON BRANDSEMA EN MIKE MULLER
28 feb. 2025 in BINNENLAND

Om alle problemen op het te krappe stroomnetwerk op te lossen en energie betaalbaar te houden voor burgers en bedrijven is er de komende vijftien jaar een investering van een duizelingwekkend bedrag van 195 miljard euro nodig. Dat is volgens ingewijden de uitkomst van een ambtelijk onderzoek naar de kosten van de energietransitie dat volgende week wordt gepresenteerd.

De kosten van netcongestie

De studie, uitgevoerd door Ecorys, laat zien dat de kosten van een overvol net aanzienlijk zijn. Zeker als bepaalde bedrijven niet kunnen uitbreiden of zich überhaupt niet in ons land kunnen vestigen. Een MWh aan elektriciteit kost onbelast ongeveer € 100 op de elektriciteitsmarkt. Maar als een bedrijf niet kan uitbreiden omdat het elektriciteitsnet vol zit, dan kost dat gemiddeld € 11.500 per MWh. Om een beeld te scheppen van de omvang: een huishouden gebruikt per jaar nu gemiddeld 2,5 MWh.

Economie • 20 mrt 09:54 • Aangepast op 20 mrt 09:54

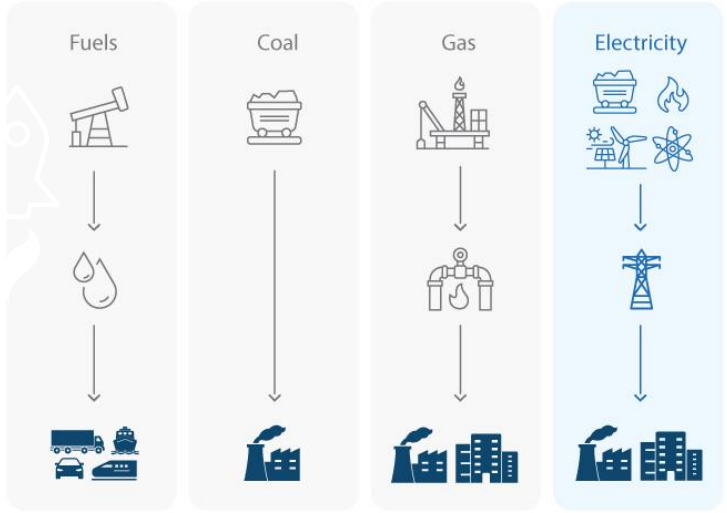
Vol stroomnet zit energietransitie in de weg: 'Laadpalen op dieselaggregaten'

Auteur: BNR Webredactie

De wachtlijst met bedrijven die wachten op een stroomaansluiting is met duizenden bedrijven gestegen. op een aansluiting op het stroomnet. Dat blijkt uit cijfers van het Landelijk Actieprogramma Netcongestie. Inmiddels zijn er ongeveer twaalfduizend ondernemers die stroom willen afnemen, maar daar nog geen toegang tot hebben. Vorig jaar in februari was de wachtlijst van netbeheerders nog gevuld met ruim negenduizend bedrijven. In twee jaar tijd is er zelfs sprake van een verdubbeling. 'Ondernemers zijn het echt spuugzat', zegt Erik Ziengs, voorzitter van ondernemersorganisatie ONL.

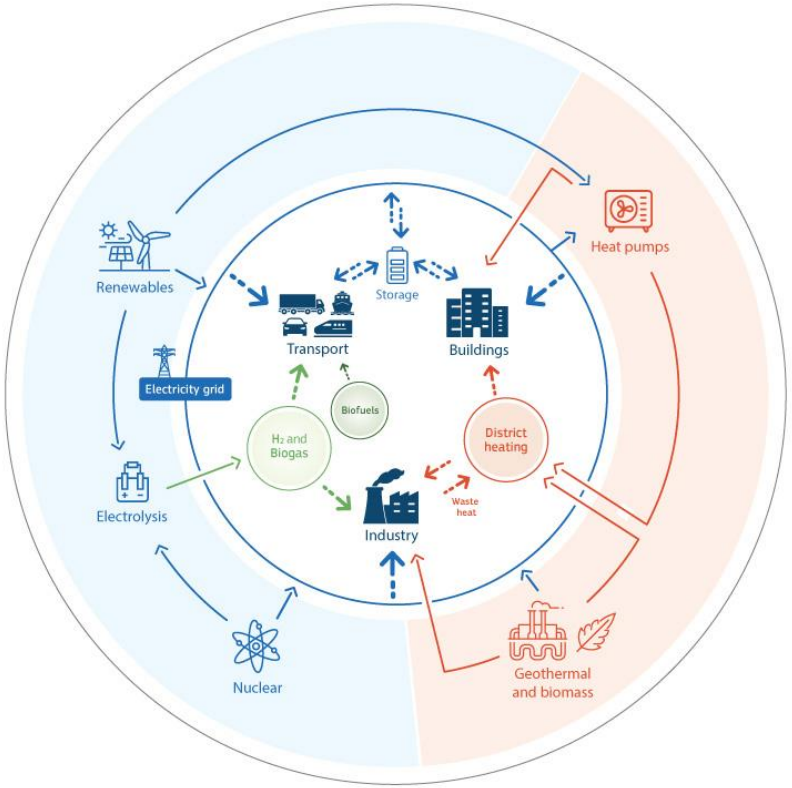
Towards a future energy system: dot on the horizon

The energy system today: linear and wasteful flow of energy, in one direction only



European Commission System Integration working group

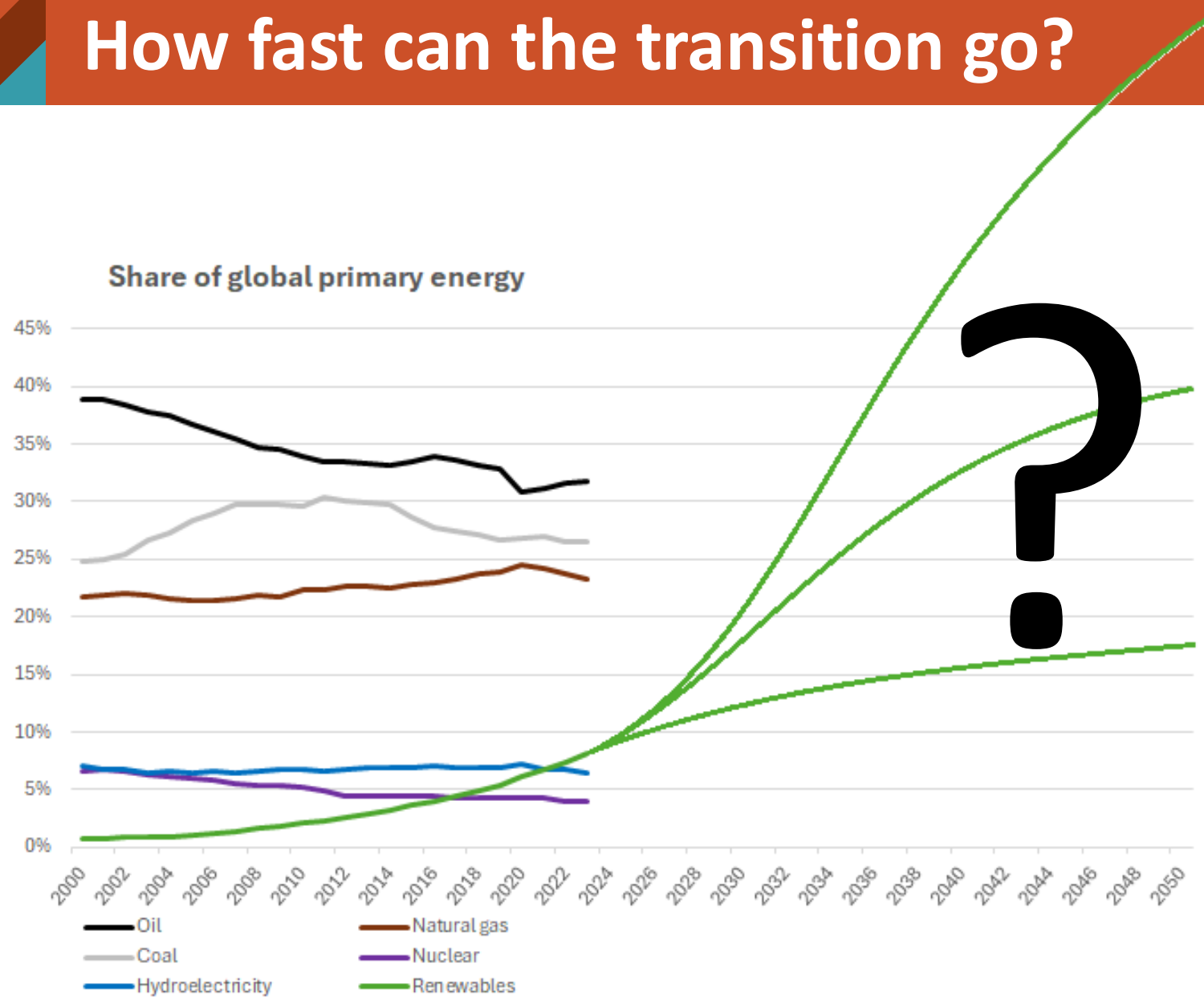
The future integrated energy system: energy flows between users and producers, reducing wasted resources and money



- A more **efficient and decentralized** system, where waste energy is captured and re-used
- A **cleaner power system**, with more direct electrification of end-use sectors such as industry, heating of buildings and transport
- A **cleaner fuel system**, for hard-to-electrify sectors such as heavy industry or transport (aviation and marine)

Consumer dynamics, modular scaling, and the ET

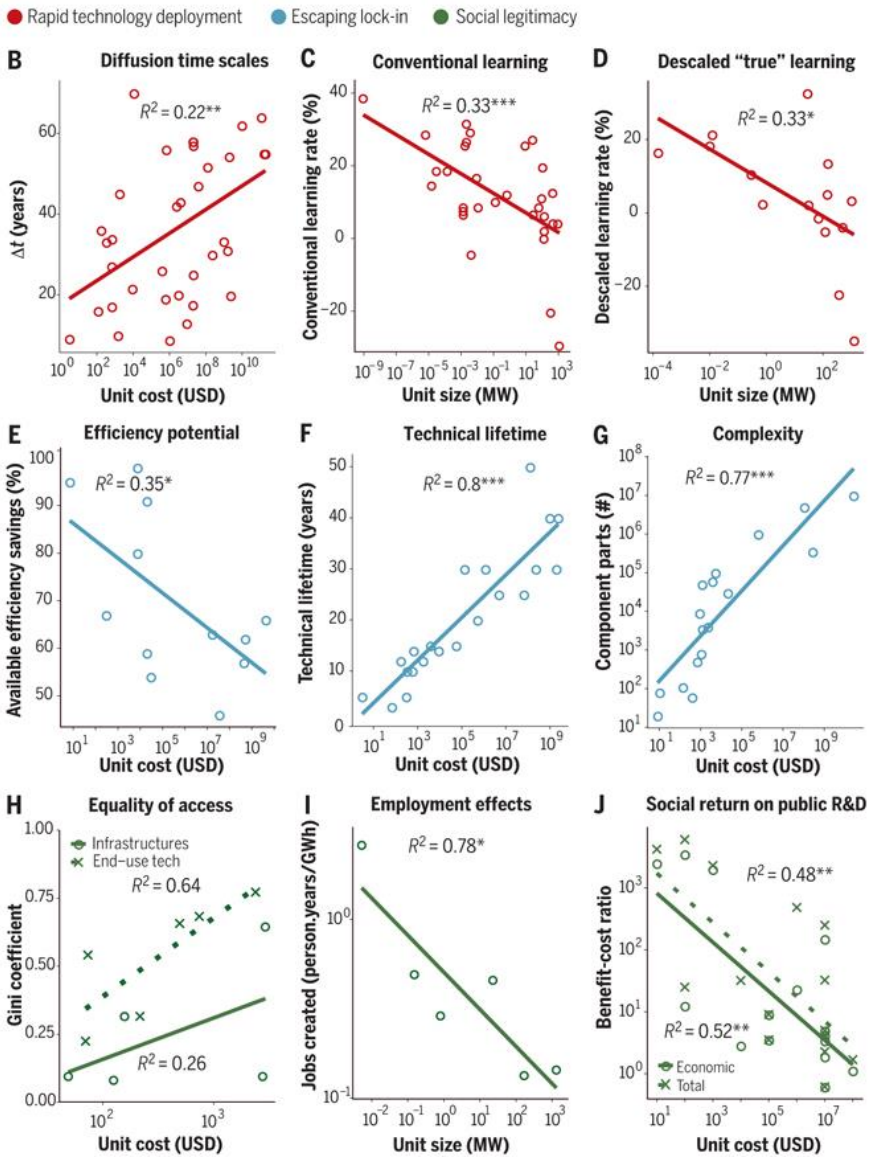
How fast can the transition go?



Speeding up by modular scaling

C Wilson et al., Science 368, 6486 (2020)

Speeding up by modular scaling



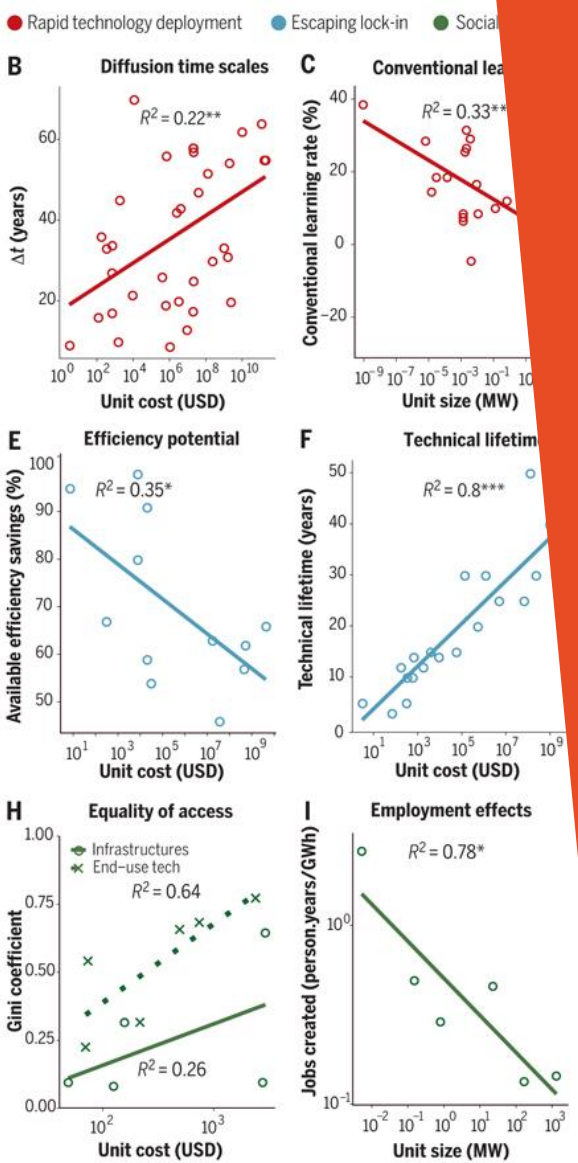
Benefits of modular technologies:

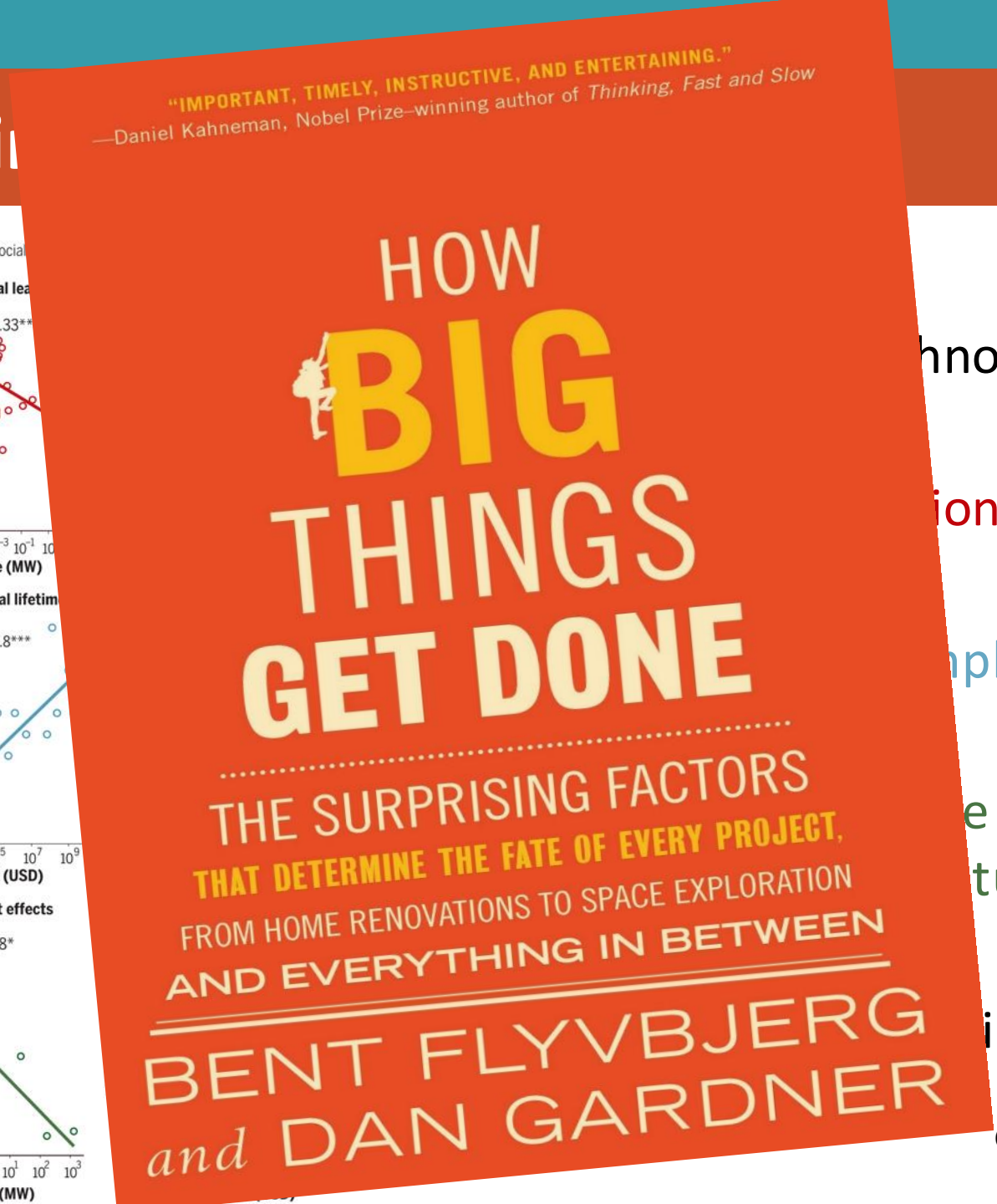
- Rapid market penetration, steep learning curves
- More efficient, less complex, less risk of lock-in
- Broader accessible, more jobs per installed capacity, higher social return on public R&D

→ Our USP – modular scaling is Brainport DNA

C Wilson et al., Science 368, 6486 (2020)

Speedi





TU/e
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hnologies:

ion, steep learning curves

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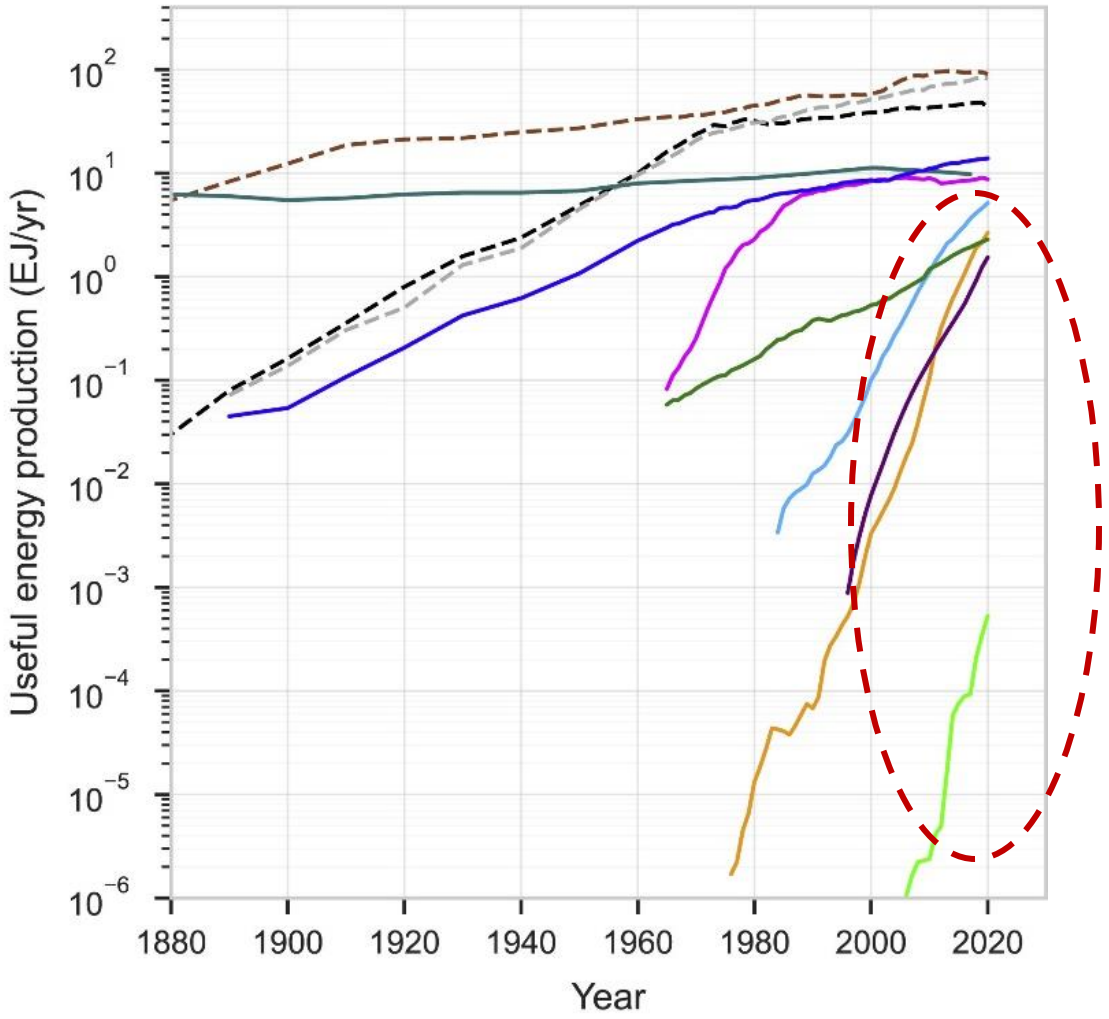
e jobs per installed

turn on public R&D

ing is Brainport DNA

C Wilson et al., Science 368, 6486 (2020)

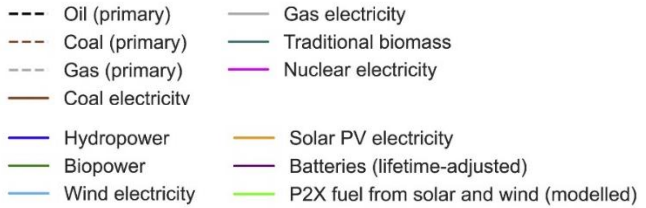
Learning curves: growth in production



Global energy production

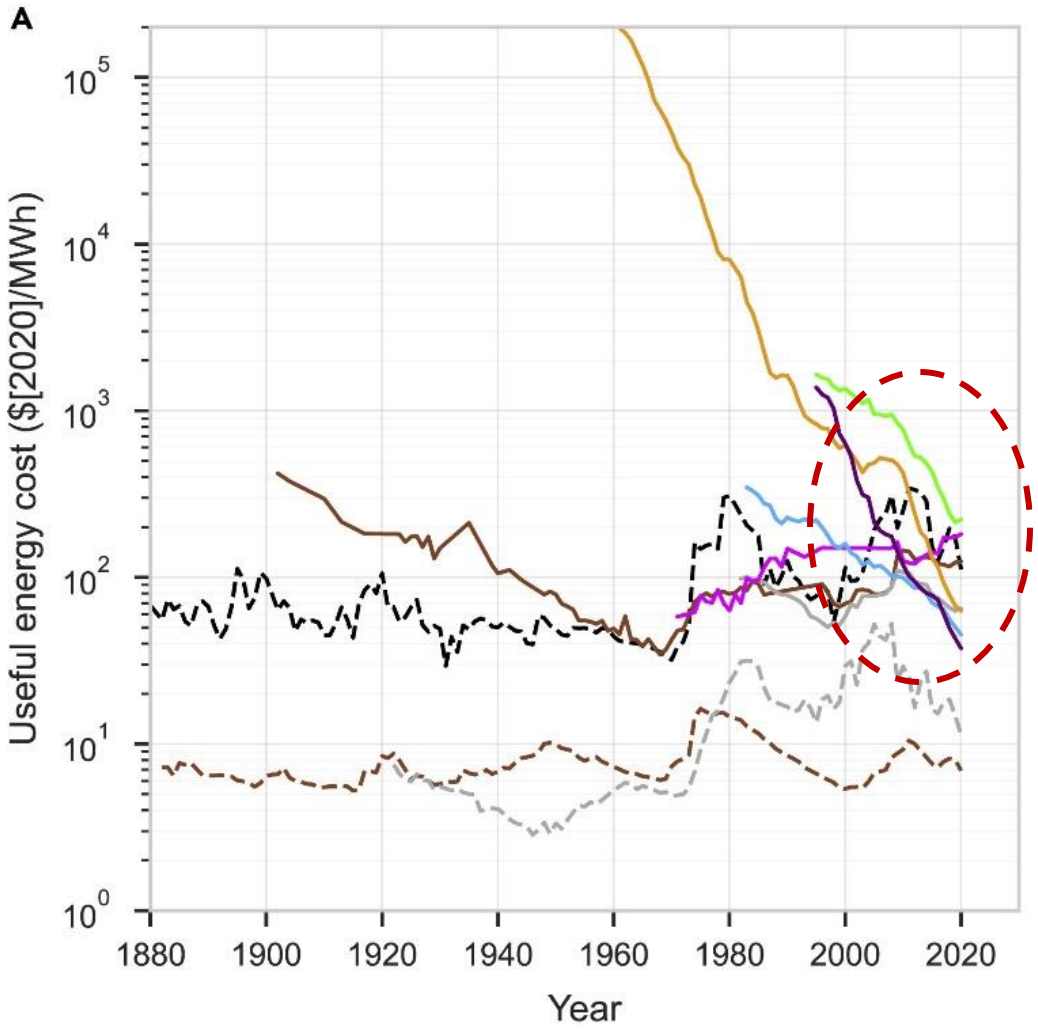
New technologies:

- Wind
- Solar-PV
- Batteries
- Power2X (H_2)



Way, R., Ives, et al. (2022). *Joule*, *6*(9), 2057-2082. https://doi.org/10.1016/j.joule.2022.08.009

Learning curves: decrease in cost



Global energy production

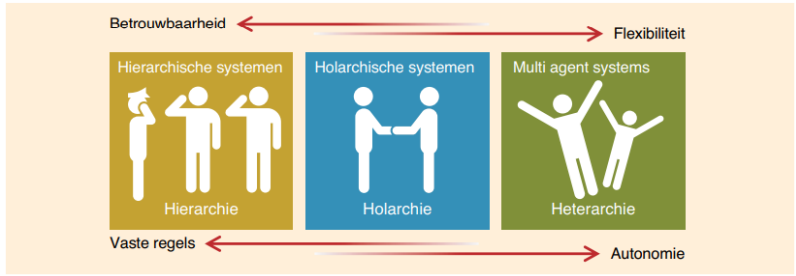
New technologies:

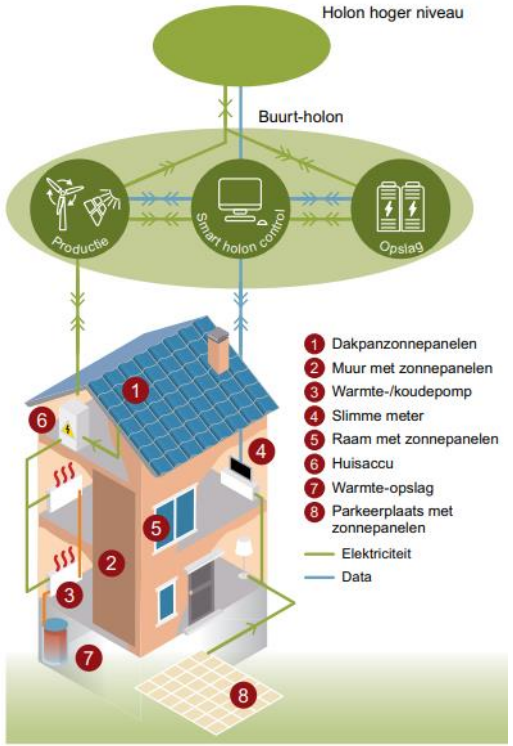
- Wind
- Solar-PV
- Batteries
- Power2X (H_2)

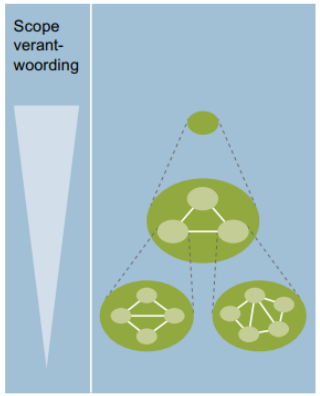
Oil (primary)
Coal (primary)
Gas (primary)
Coal electricitv
Hydropower
Biopower
Wind electricity
Gas electricity
Traditional biomass
Nuclear electricity
Solar PV electricity
Batteries (lifetime-adjusted)
P2X fuel from solar and wind (modelled)

Way, R., Ives, et al. (2022). *Joule*, *6*(9), 2057-2082. https://doi.org/10.1016/j.joule.2022.08.009

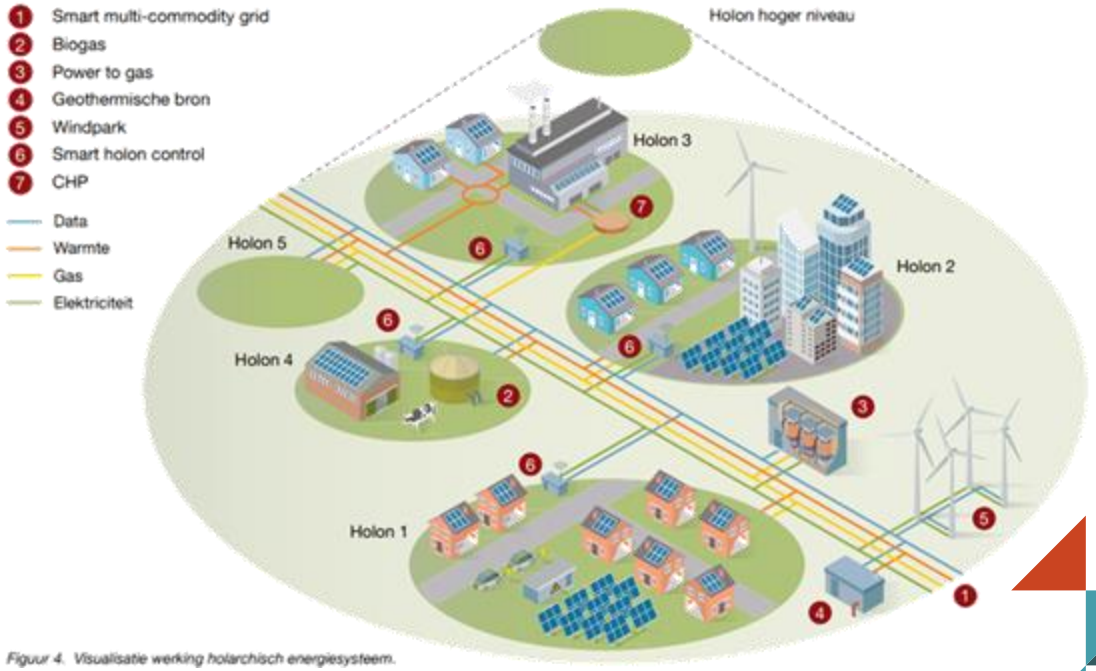
Organizing our future energy system in a modular way







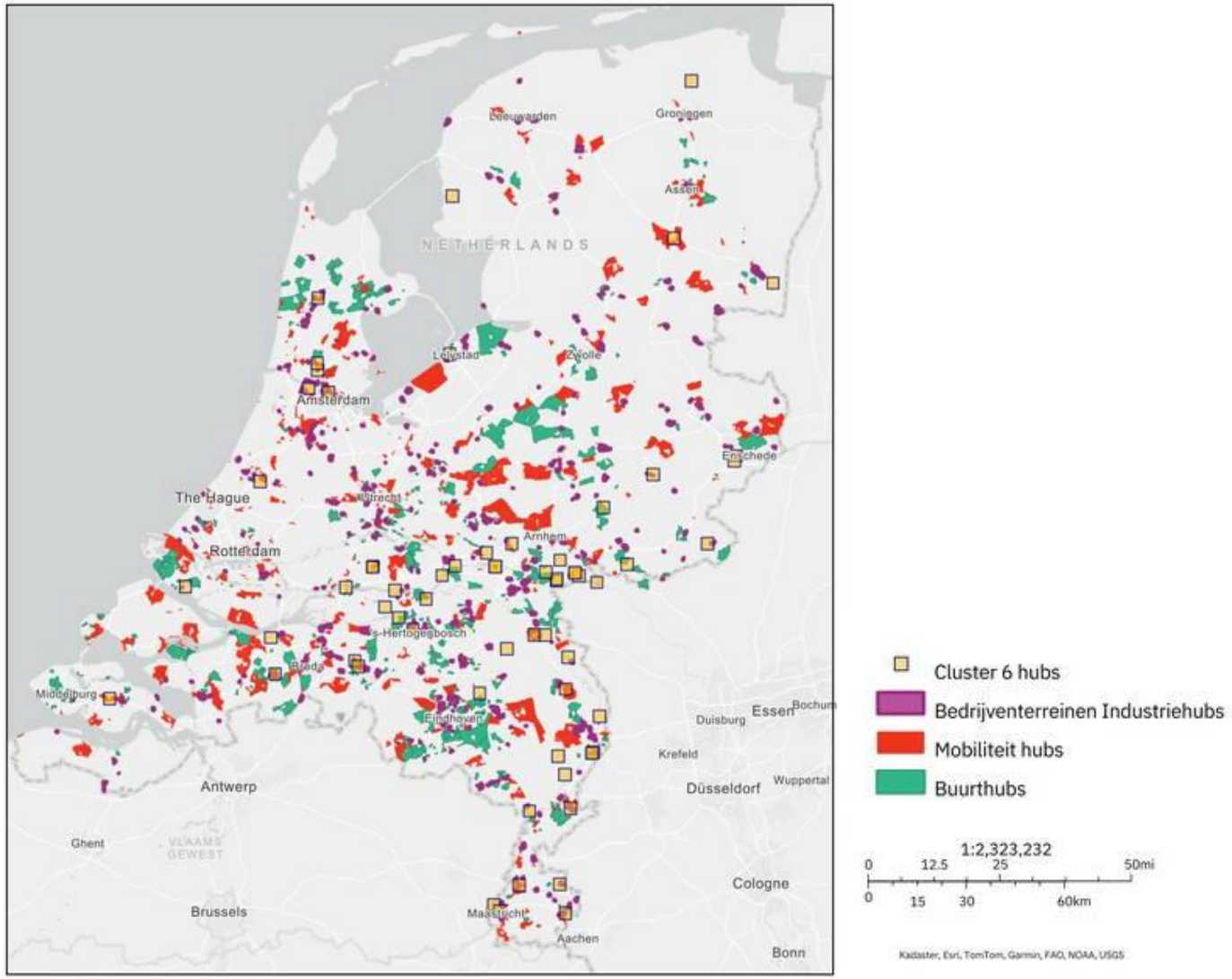
Topsector Energie, Systeemintegratie



Figuur 4. Visualisatie werking holarchisch energiesysteem.

Implementation starting up

Kansrijke Energy Hub locaties



‘Lokaal wat kan, centraal wat moet’

- 1200 potential energy hub locations

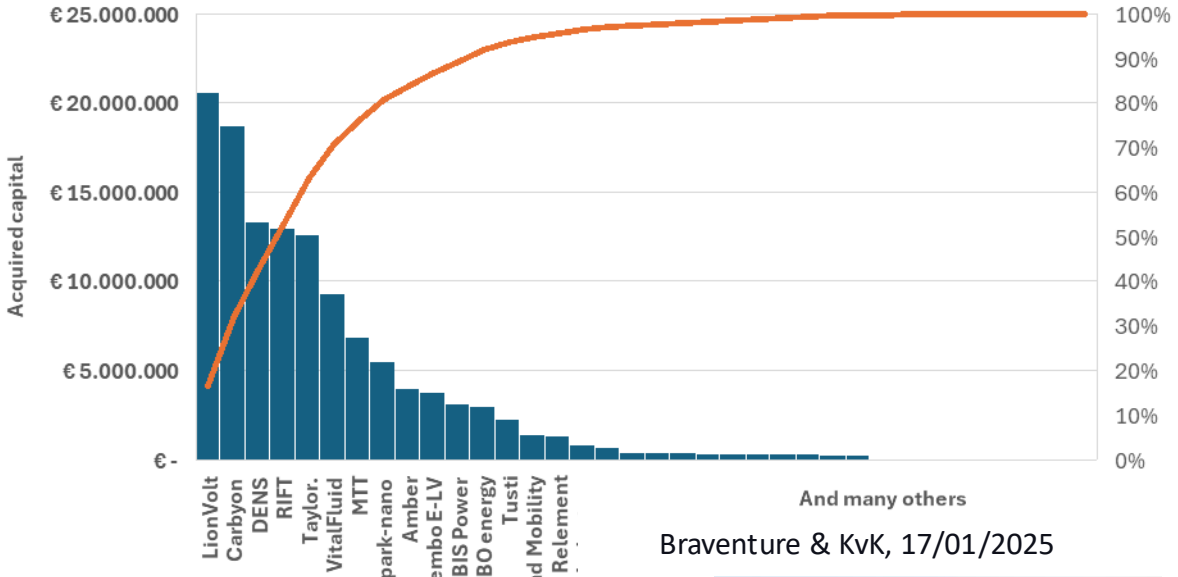
- Four families
- Built environment
- Mobility
- Business areas
- Cluster 6 industry sites

- Potential mitigation of 3.2 GWp

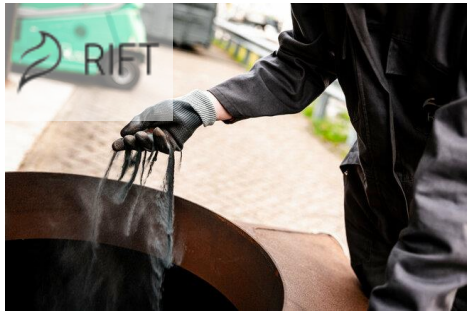
Rapport TS Energie Systeemintegratie 26/8/2024

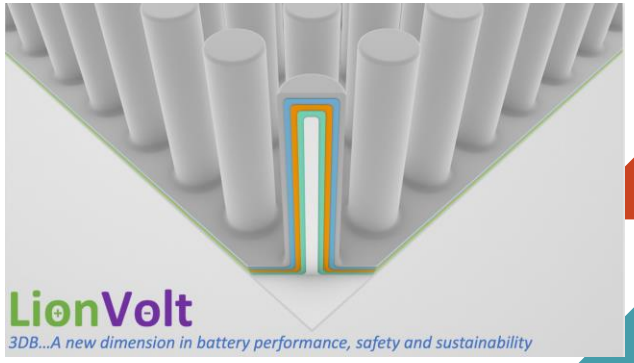
Many startups push this approach

Classification	# companies
Environment & recycling	40
Transport & logistics	22
Electrical - Grid & components	21
Electrical -PV	15
Energy systems - Heat cooling	15
Electrical - Batteries	7
Electrochemical (H2)	4
Process & mechanical componer	4
Health	4
Electrical - wind	3
	135



Braventure & KvK, 17/01/2025





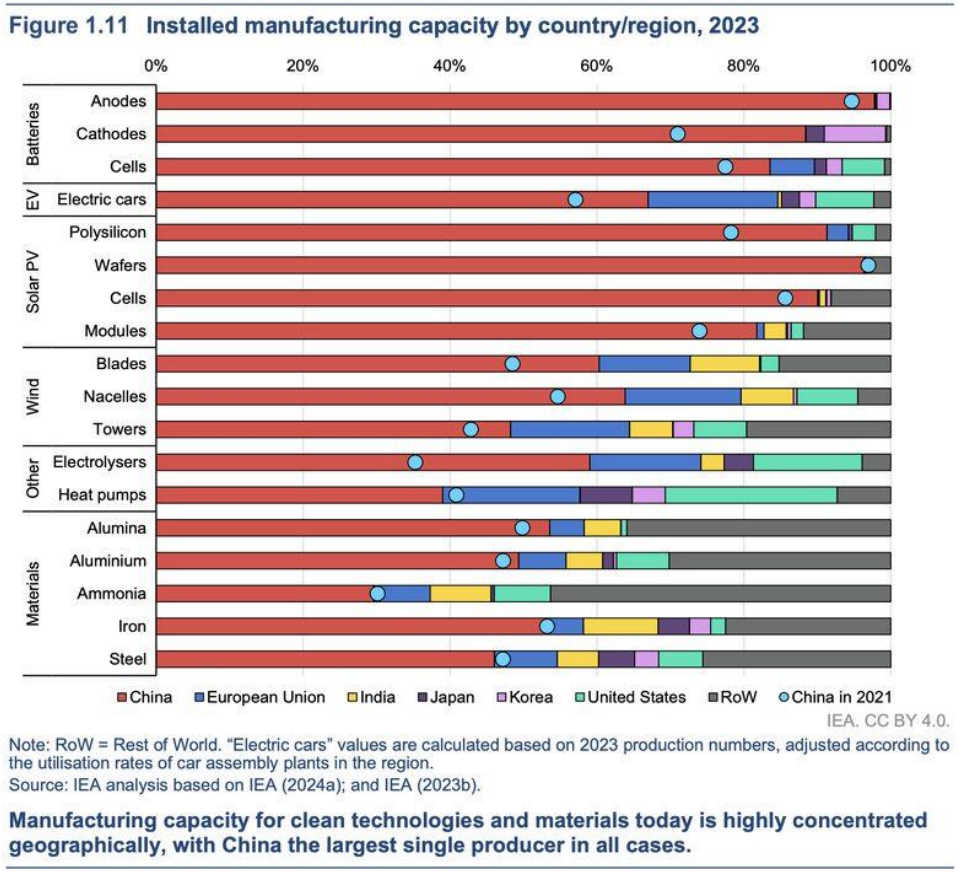
Considerations regarding ET technology development

How to do this without creating new problems?

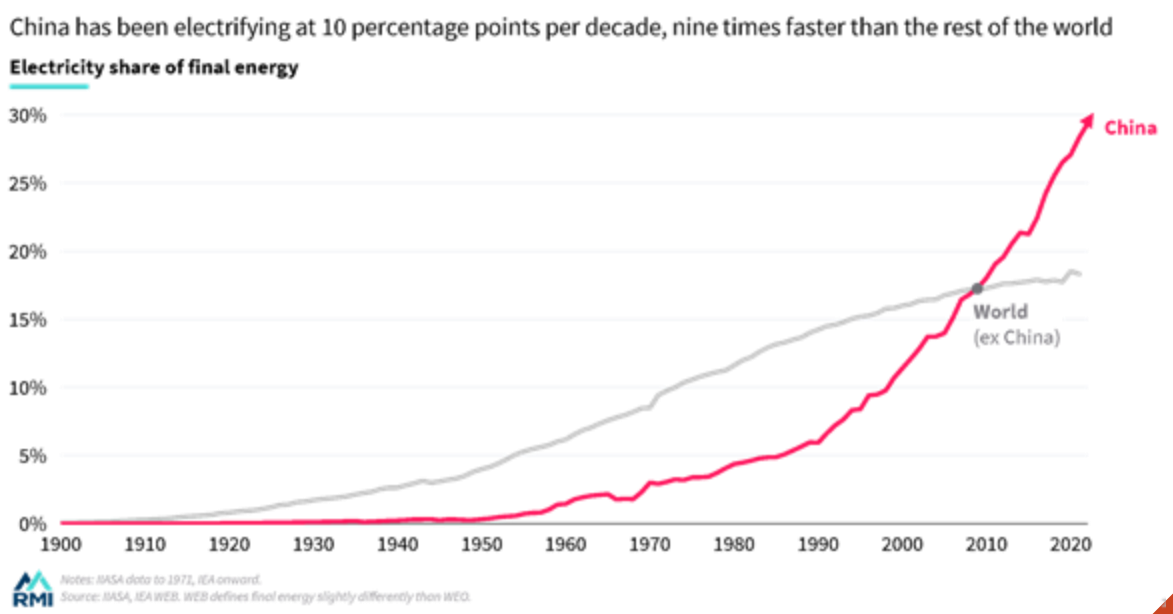
The decentralized nature of the energy system of the future increases its vulnerability to all kinds of malicious behavior: (cyber)security becomes essential!

How to do this without creating new problems?

It also requires (re)establishing our own manufacturing base and supply lines

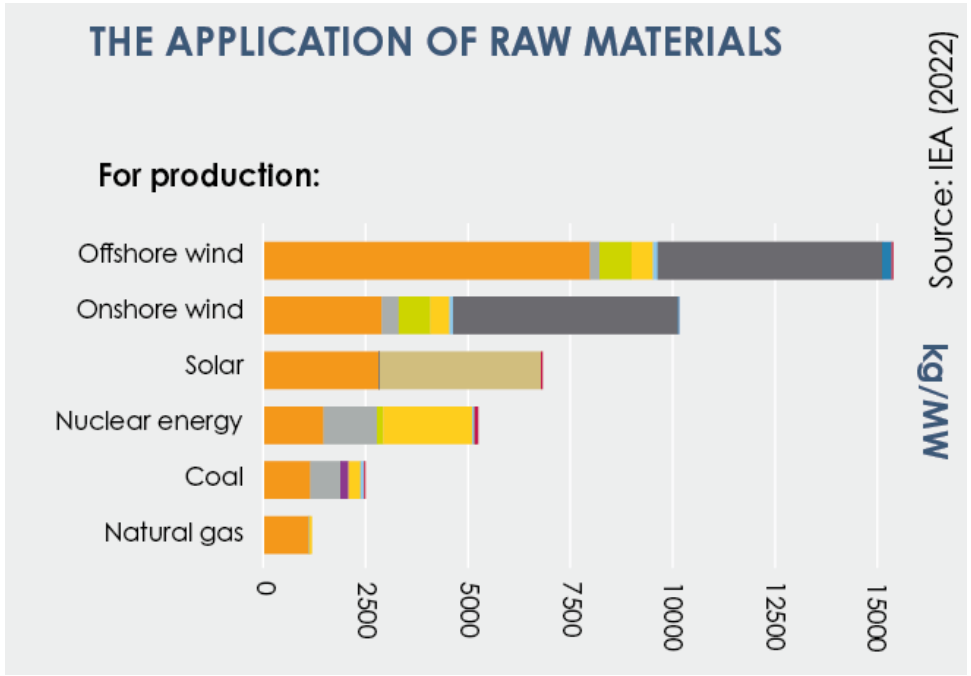


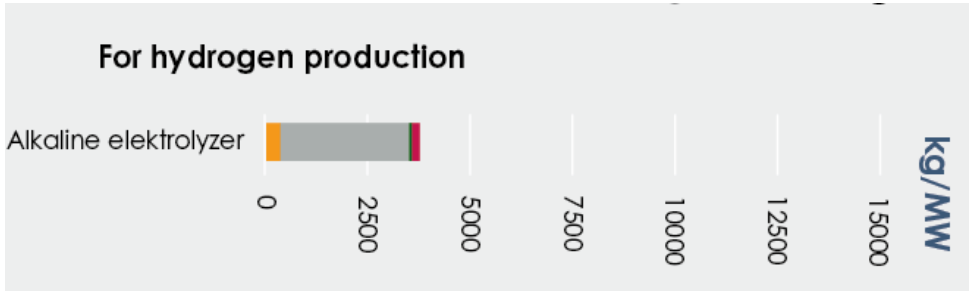
IEA Energy Technology Perspectives 2024

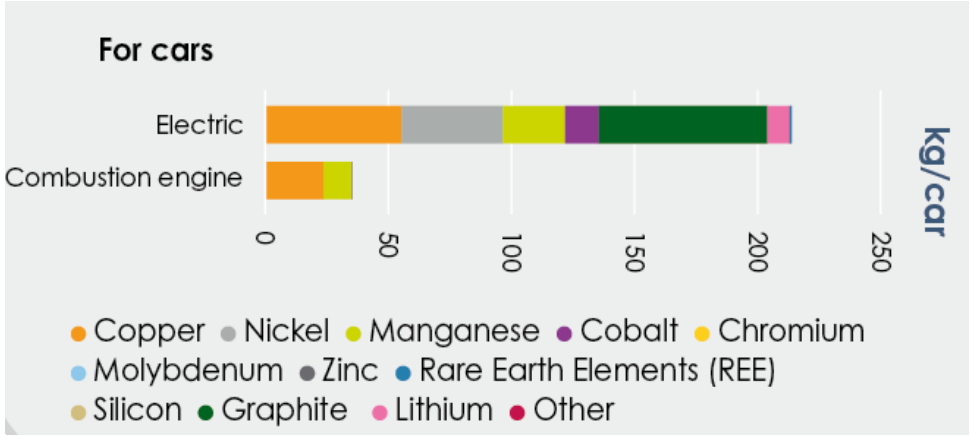


How to do this without creating new problems?

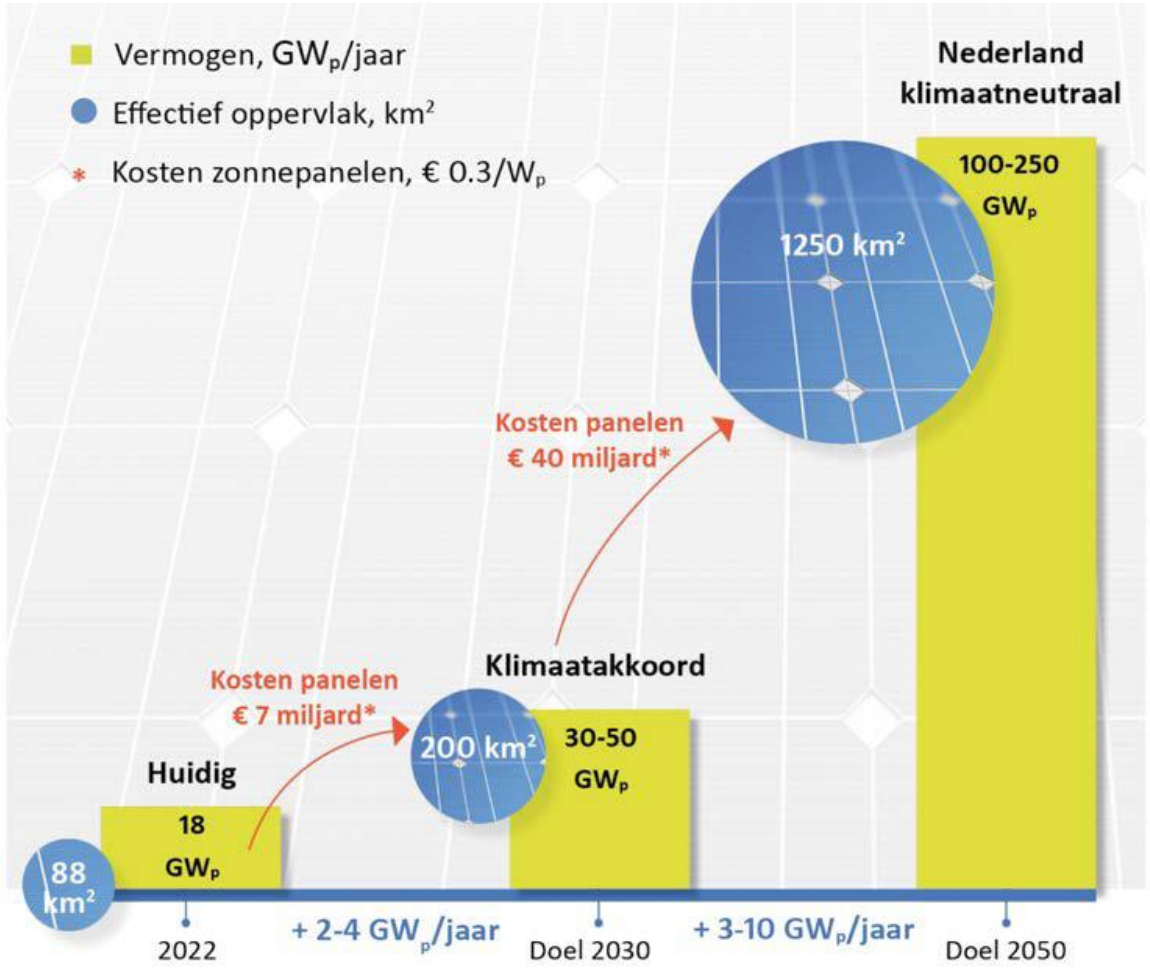
Changing from **energy** as commodity to **energy devices** as commodity risks changing our globe from a **greenhouse** to a raw/rare materials **scrap heap**.







Take for example PV



- Plans in SolarNL mean that we need to produce ~1 m^2 per second for NL only (!) in the coming 28 years.
- Given lifetime/replacement rate, we will keep on producing ~1 m^2 per second after that as well.
- Good for business – but not for materials usage. We need to make sure that we do this with design-to-recycle and end of life treatment in mind.
- What does this mean for perovskites and other multilayer solar cells?

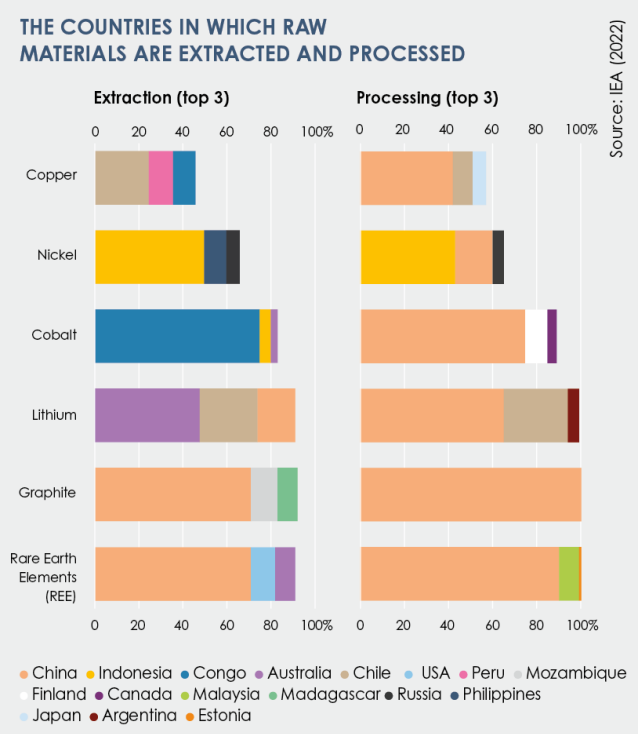
NGF SolarNL

© Reuter, The Atlantic
A worker rides a shared bicycle past a huge pile of unused shared bikes in a vacant lot in Xiamen, Fujian province, China, on December 13, 2017.

© Yibo Wang , The Atlantic
This is not a field of tulips, but a drone's-eye-view of tens of thousands of unused share bikes lined up in a field near Shanghai.

How to do this without creating new problems?

On top of this we must face geopolitical dependencies and the way materials are extracted (e.g. treatment of miners) and produced (e.g. PFAS)



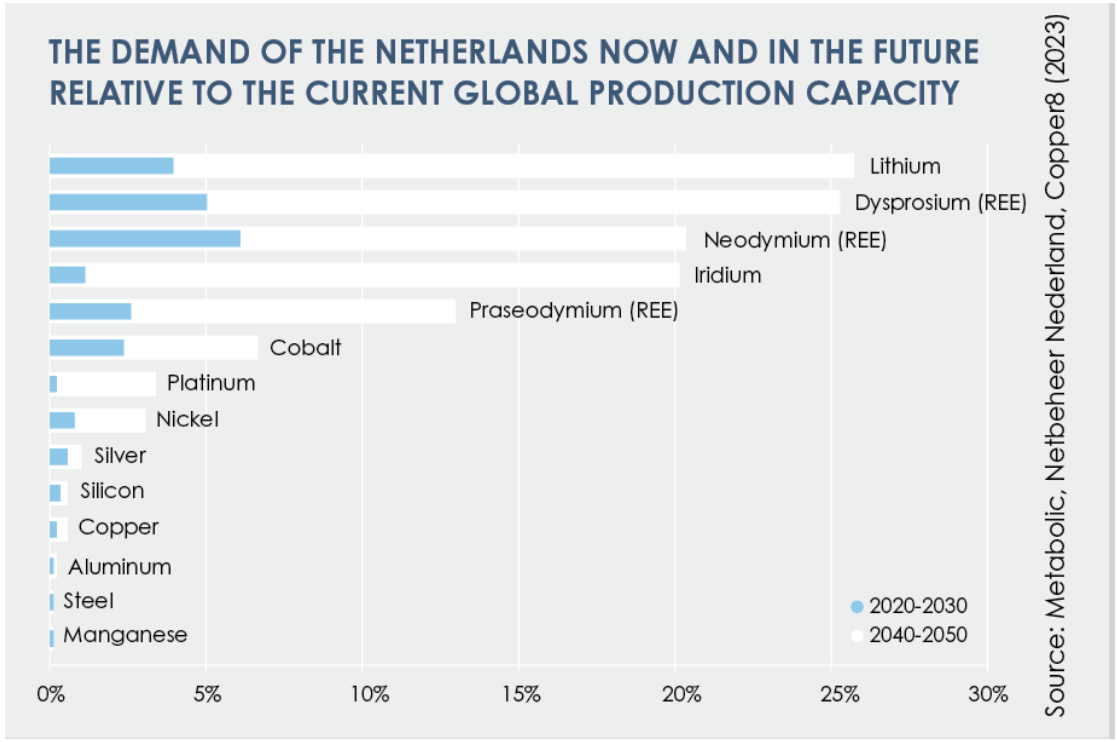


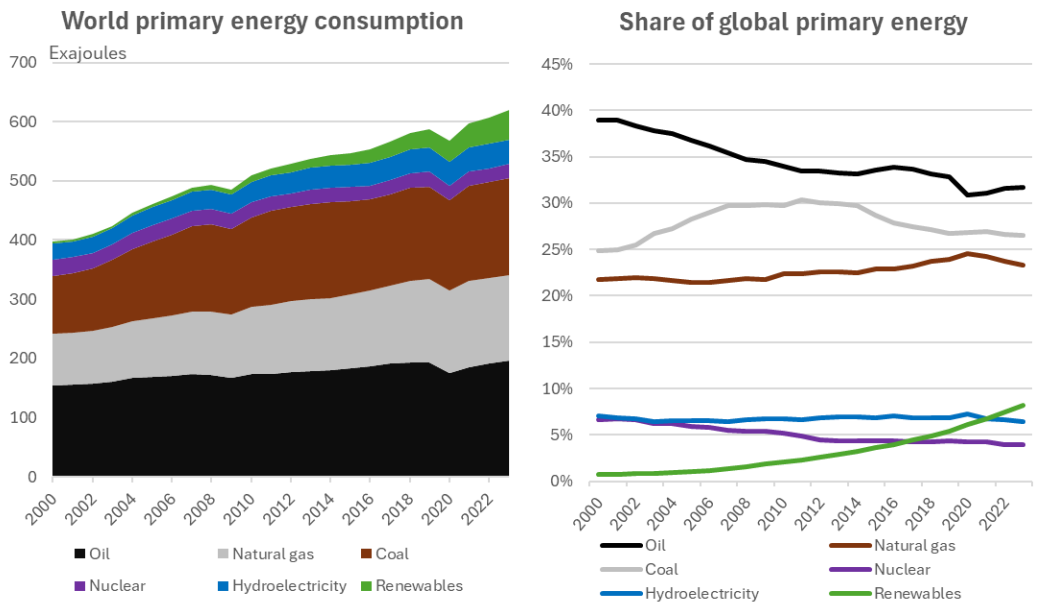
Photo Credit: ***© Michael Robinson Chavez/The Washington Post/Getty Images***
A "creuseur," or digger, descends into a tunnel at the cobalt mine.
Kawama, Democratic Republic of the Congo. June 8, 2016.

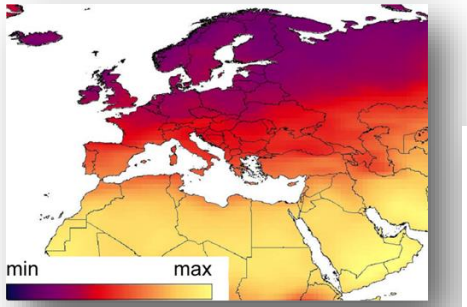
Wrap up & conclusions

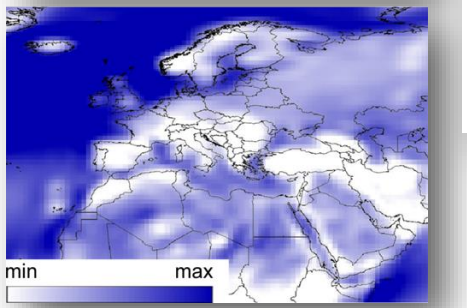
Image credits: Irma Kniilva, The Walrus, CA

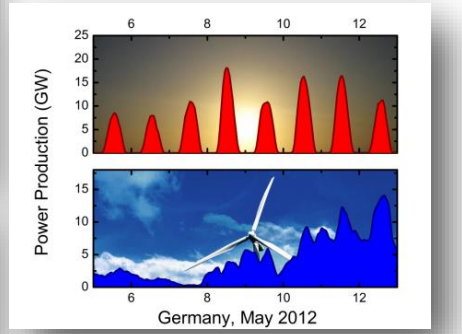
Conclusions (1/3)

- Energy transition requires **rapid acceleration** and **radical system change**.
- Key challenge is the **transport**, **conversion**, and **storage** of energy.





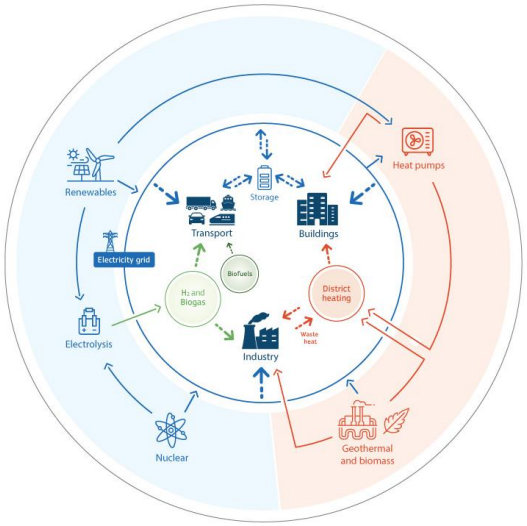


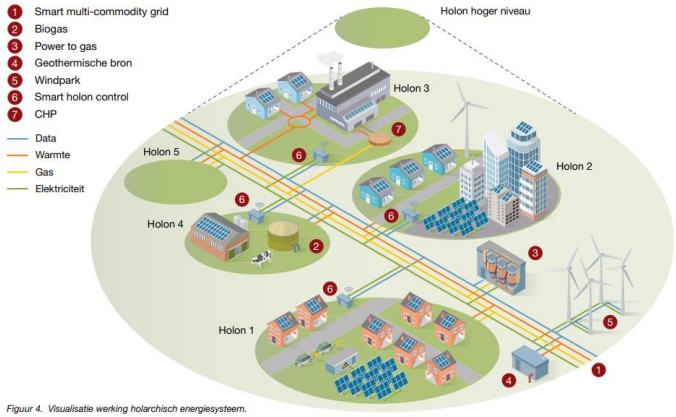


Conclusions (2/3)

- This asks for a **redesign of our current energy system** and the way we interact with it.

- **Modular scaling** and a **holarchic lay out** of the energy system provide **acceleration pathways**.



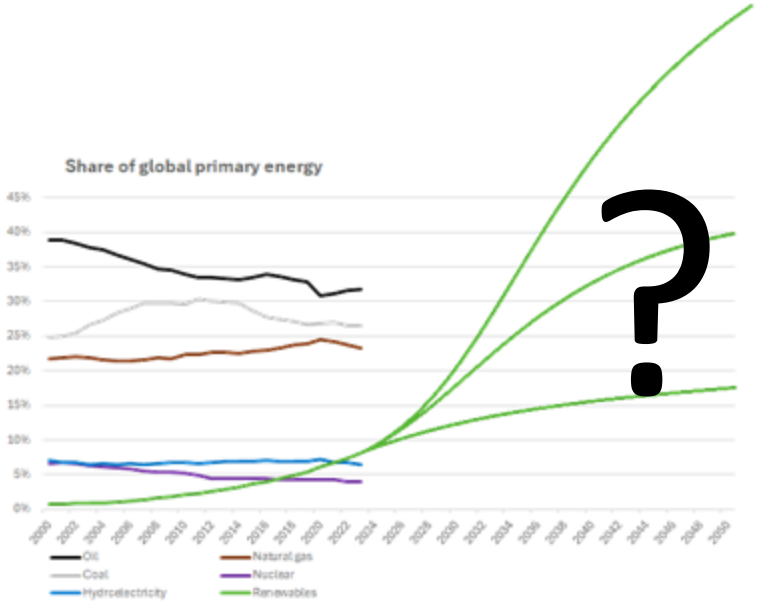


Figuur 4. Visualisatie werking holarchisch energiesysteem.

Conclusions (3/3)

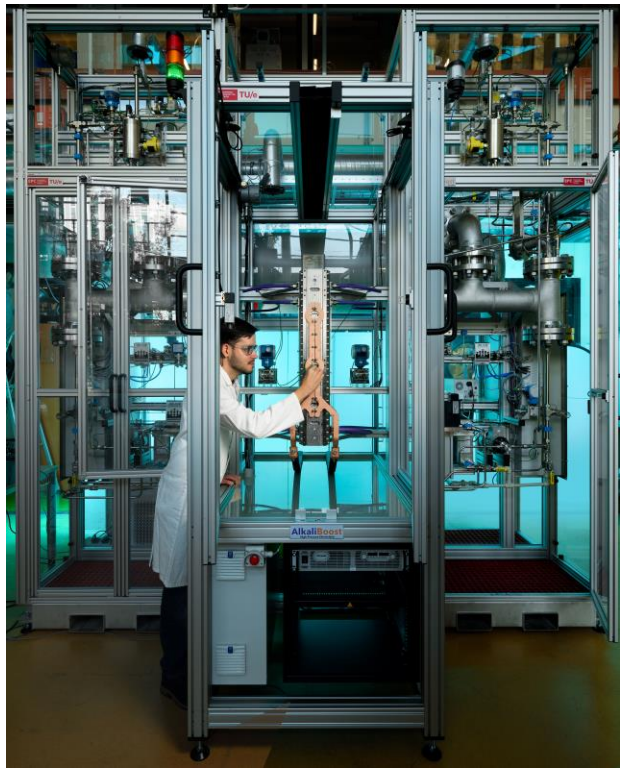
- But this requires attention for our **manufacturing industry**, **(cyber)security**, and **circularity**.

- If we can do this in a **fair way** and **fast enough** will depend on the actions of our generation!



<commercial break>

- At EIRES we work on this challenge by **connecting researchers with societal partners** and by **creating impact with student teams and startups**.
- **You are most welcome to join!**



THANK YOU
for your attention

more info: tue.nl/eires