

IMPACTS THE CURRENT ENERGY CRISIS AND AN EFFECTIVE RESPONSE THAT ACCELERATES THE ENERGY TRANSITION

EEAC ONLINE POLICY BRIEFING

THE ENERGY TRANSITION IN THE CONTEXT OF GEOPOLITICAL DEVELOPMENTS

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TNO innovation
for life



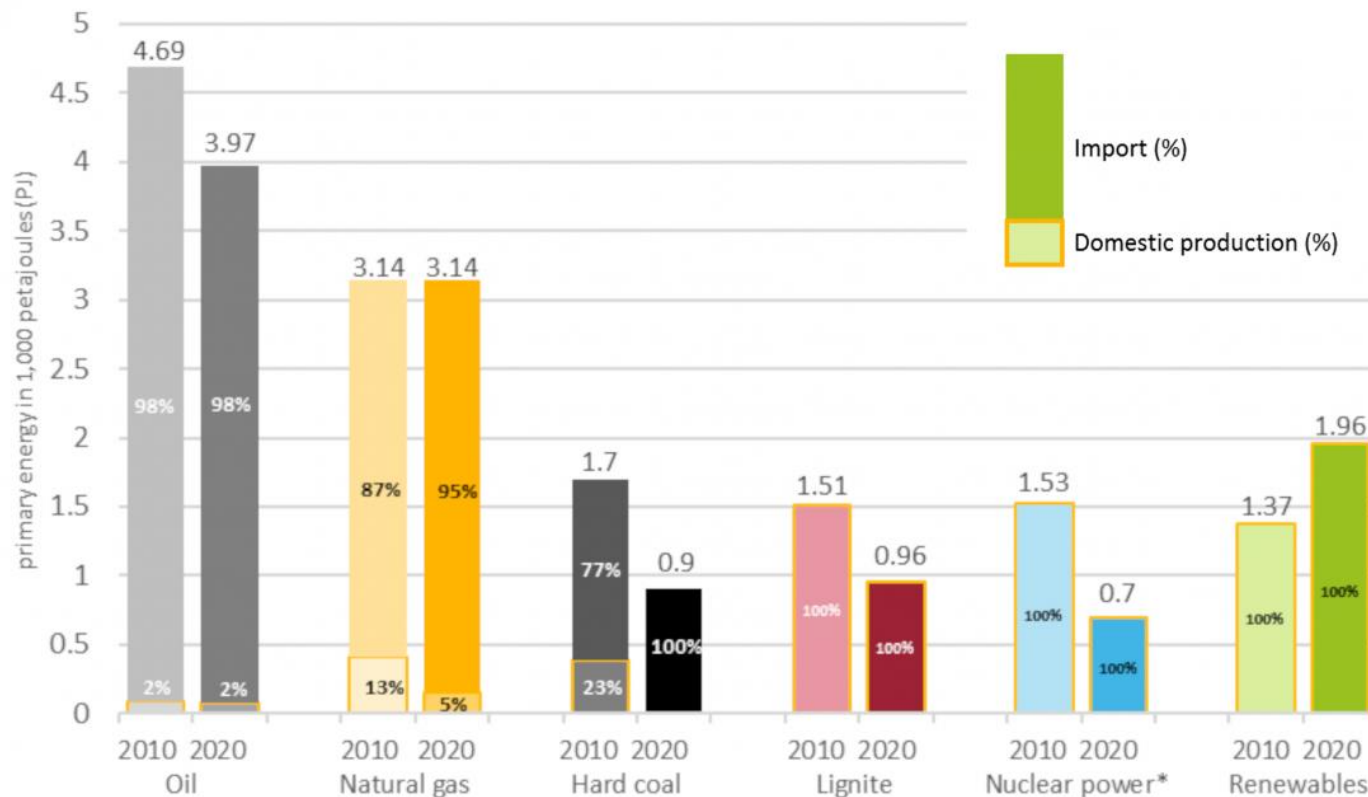
THE ENERGY IMPORT DEPENDENCY OF THE EU...

TNO innovation
for life

Import dependency by primary energy source 2010 and 2020 for Germany.

Data: BGR 2022.

CLEAN
ENERGY
WIRE

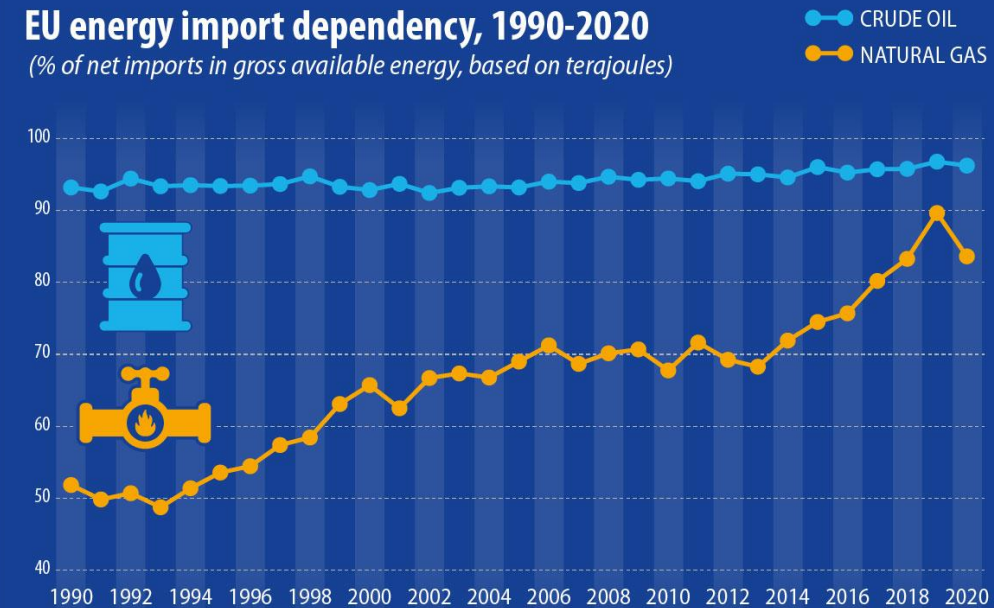


*While the uranium is imported, nuclear energy is considered domestic, as significant additional production steps in Germany/Europe are necessary to turn it into fuel rods.

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EU energy import dependency, 1990-2020

(% of net imports in gross available energy, based on terajoules)



#EUIndustryDays

ec.europa.eu/eurostat

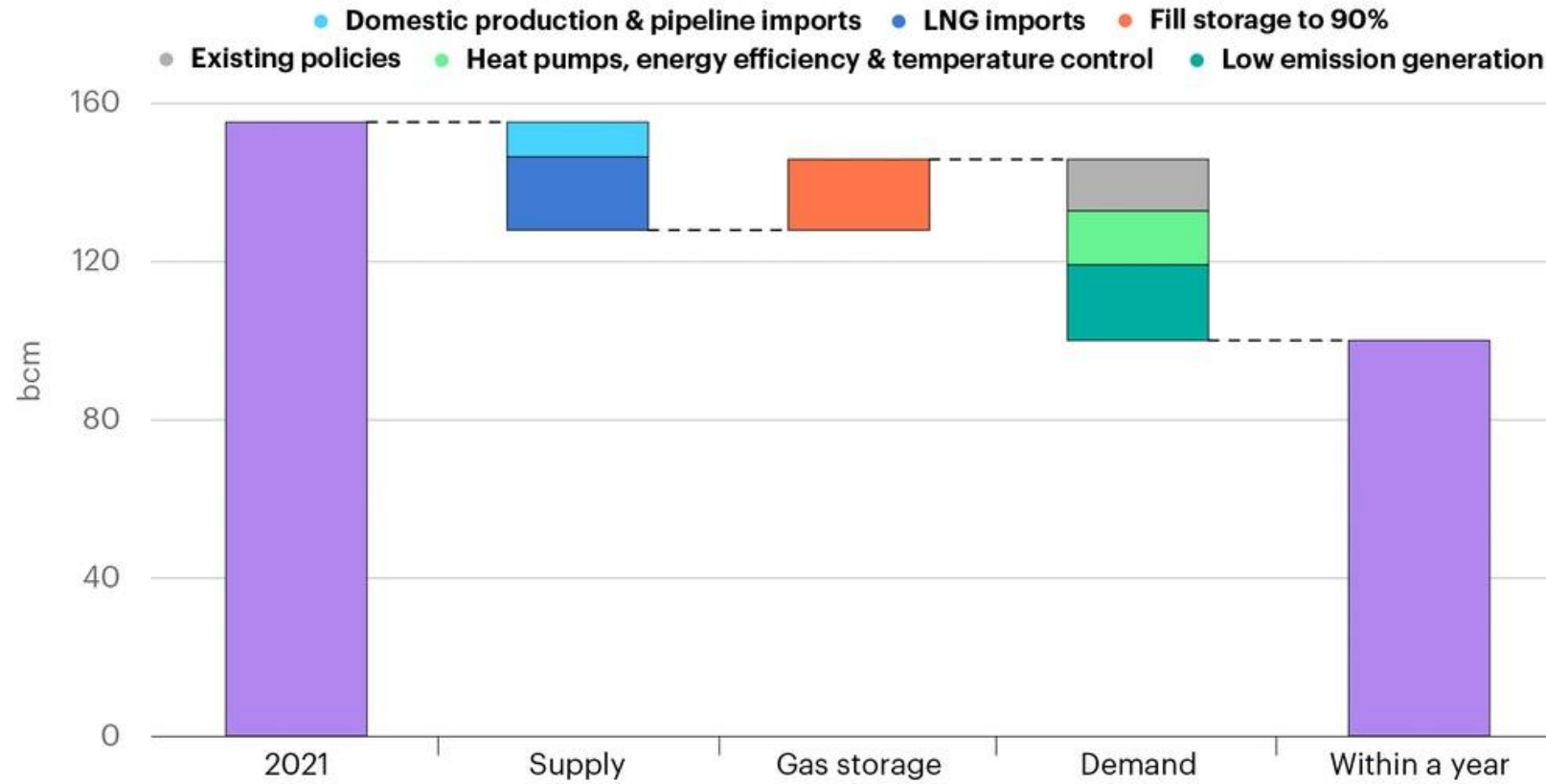
~400 Billion Euro/yr energy import.
Pre-covid price levels!

Share Russia in imports (2019): NG; 41%, oil:27%, coal 47%

- › Current energy price levels are disruptive and about a guarantee for a recession in the EU when sustained at current levels (e.g. rule of thumb: each 20 U\$/barrel price increase cuts GDP growth by 0,5%)
- › Energy poverty is observed among large groups in society. Short term (panic) response is to subsidize/lower taxes.
- › Lowering demand due to price effects and loss of competitiveness of various industries.
- › Swift response expected from key fossil energy exporters (US, Canada, possibly Venezuela, Iran, Qatar, Saudi Arabia...); longer term could also mobilize countries like Mozambique, Brazil, etc)
- › Cutting Russian fossil energy imports will partially be compensated by increased use of other buyers on the global market (possibly at lower price levels).
- › Quick shifts in energy supply mix (more coal, prolong operation nuclear capacity, biomass use)

10 POINT PLAN IEA TO REDUCE RUSSIAN GAS IMPORTS OF EU WITHIN A YEAR

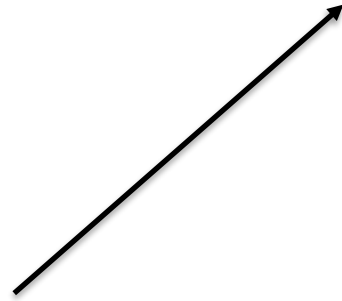
EU gas imports from Russia



International
Energy Agency

ACCELERATING THE ENERGY TRANSITION

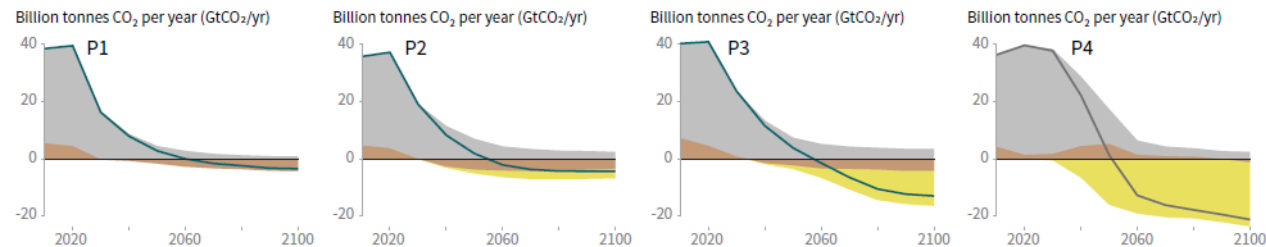
Implications for the Netherlands:



IPCC 1,5oC report:

Breakdown of contributions to global net CO₂ emissions in four illustrative model pathways

● Fossil fuel and industry ● AFOLU ● BECCS



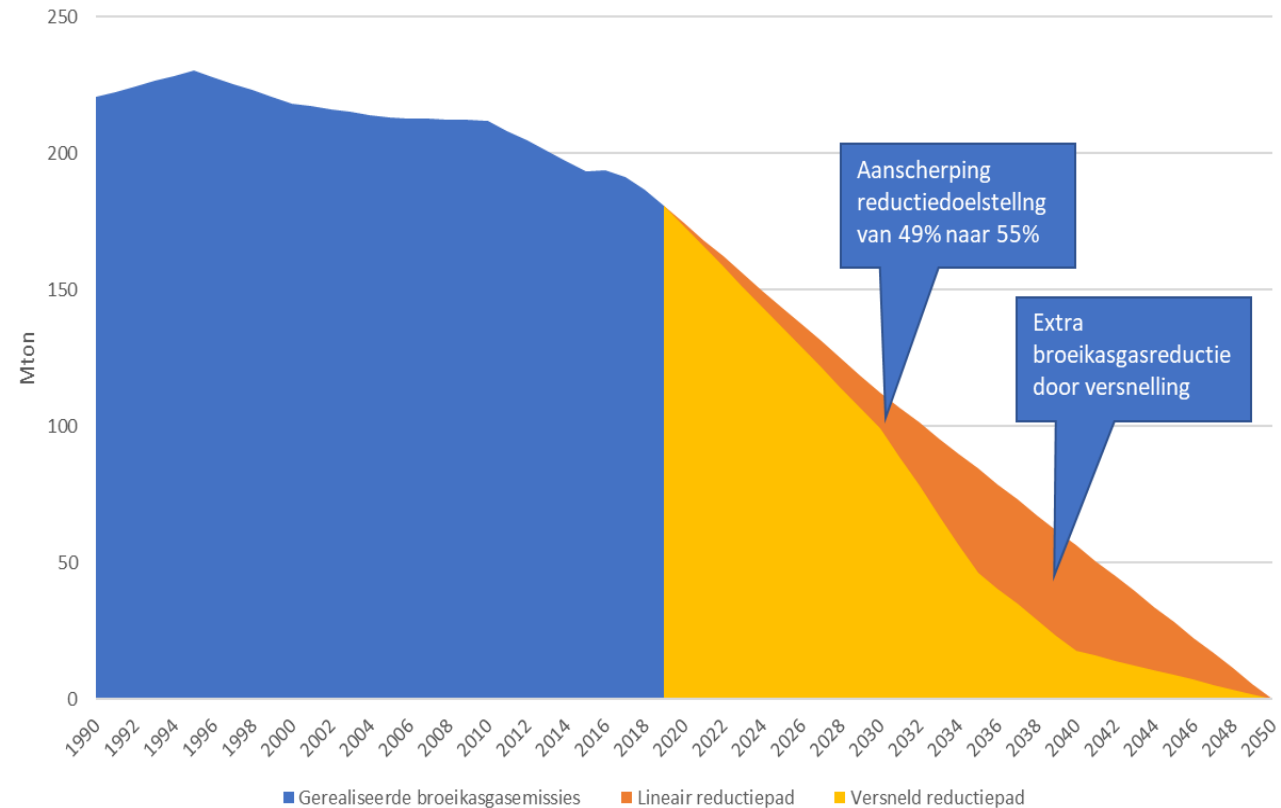
P1: A scenario in which social, business and technological innovations result in lower energy demand up to 2050 while living standards rise, especially in the global South. A downsized energy system enables rapid decarbonization of energy supply. Afforestation is the only CDR option considered; neither fossil fuels with CCS nor BECCS are used.

P2: A scenario with a broad focus on sustainability including energy intensity, human development, economic convergence and international cooperation, as well as shifts towards sustainable and healthy consumption patterns, low-carbon technology innovation, and well-managed land systems with limited societal acceptability for BECCS.

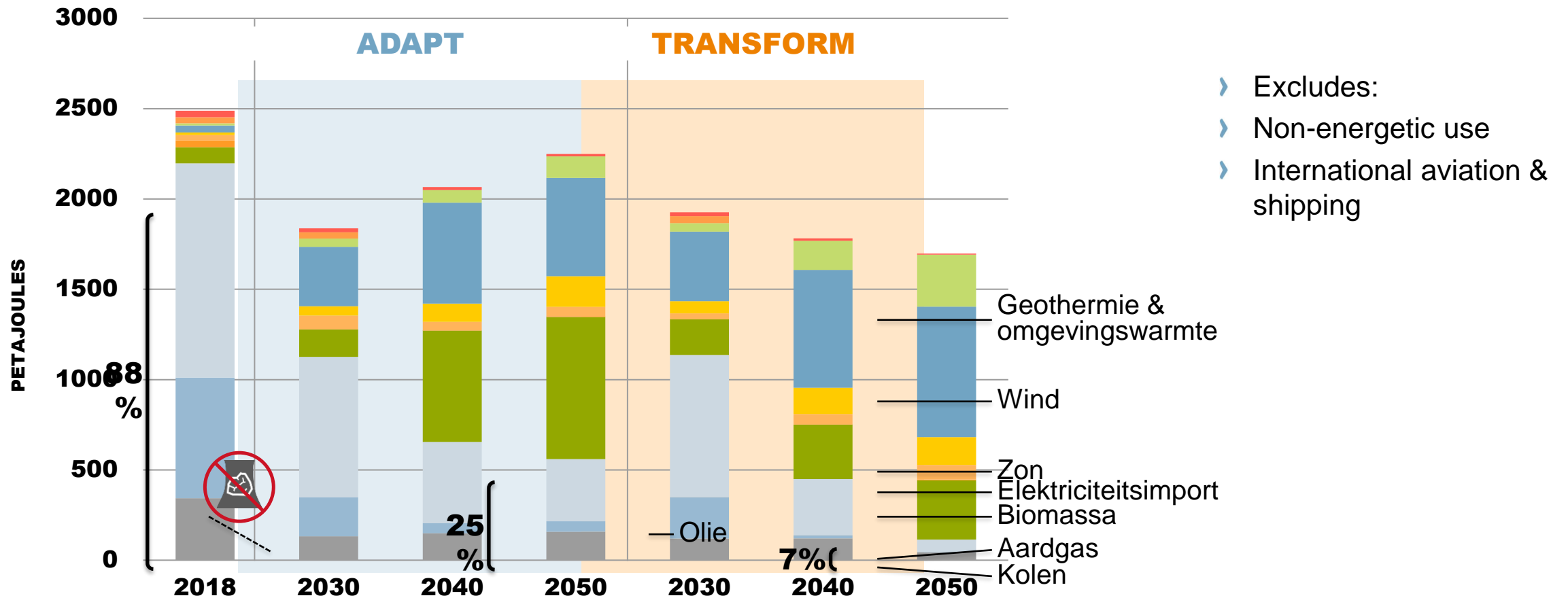
P3: A middle-of-the-road scenario in which societal as well as technological development follows historical patterns. Emissions reductions are mainly achieved by changing the way in which energy and products are produced, and to a lesser degree by reductions in demand.

P4: A resource- and energy-intensive scenario in which economic growth and globalization lead to widespread adoption of greenhouse-gas-intensive lifestyles, including high demand for transportation fuels and livestock products. Emissions reductions are mainly achieved through technological means, making strong use of CDR through the deployment of BECCS.

Reductiepaden broeikasgasen voor Nederland

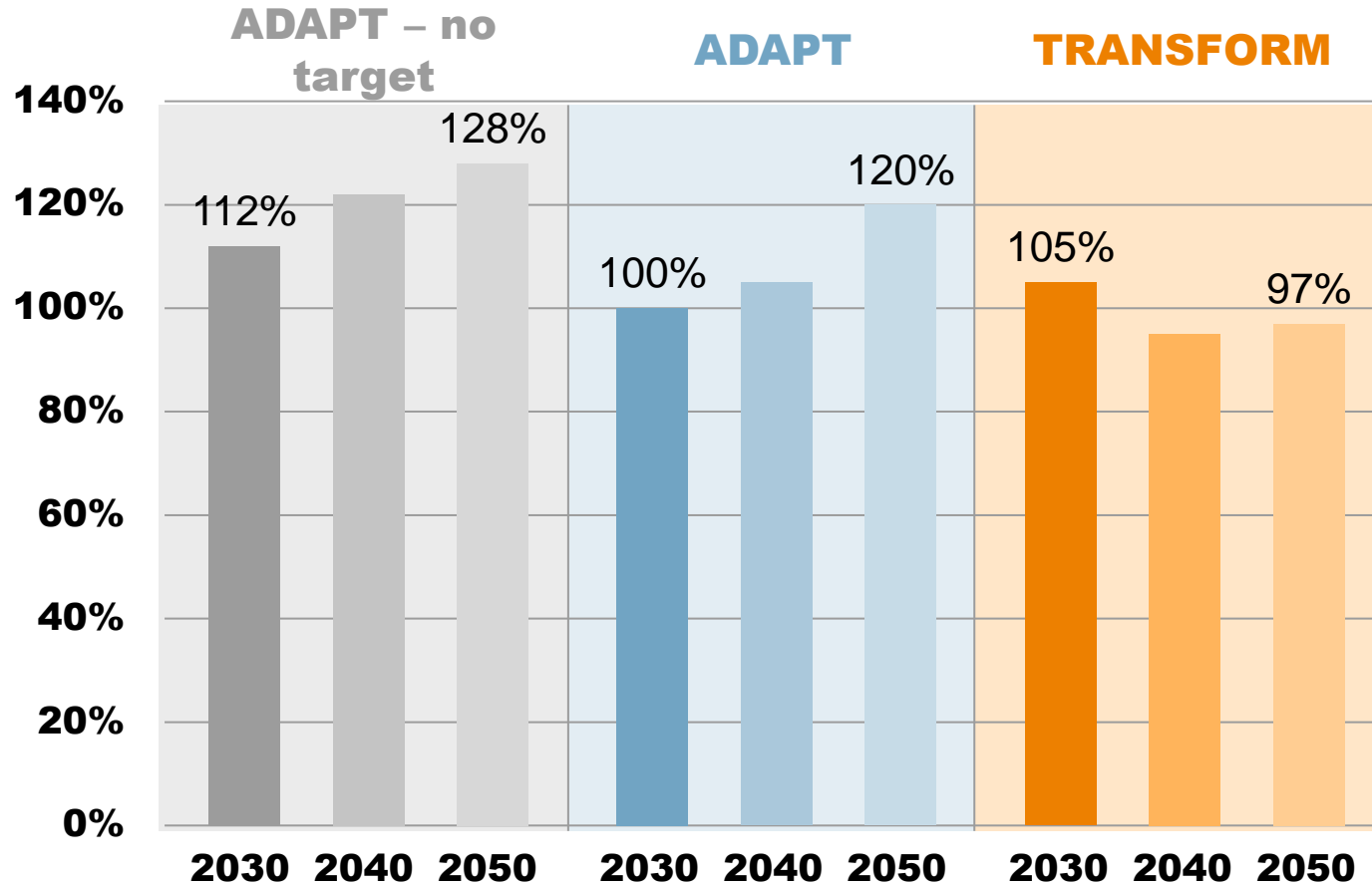


2 FUTURE ENERGY SCENARIO'S FOR THE NETHERLANDS; PRIMARY ENERGY SUPPLY MIX

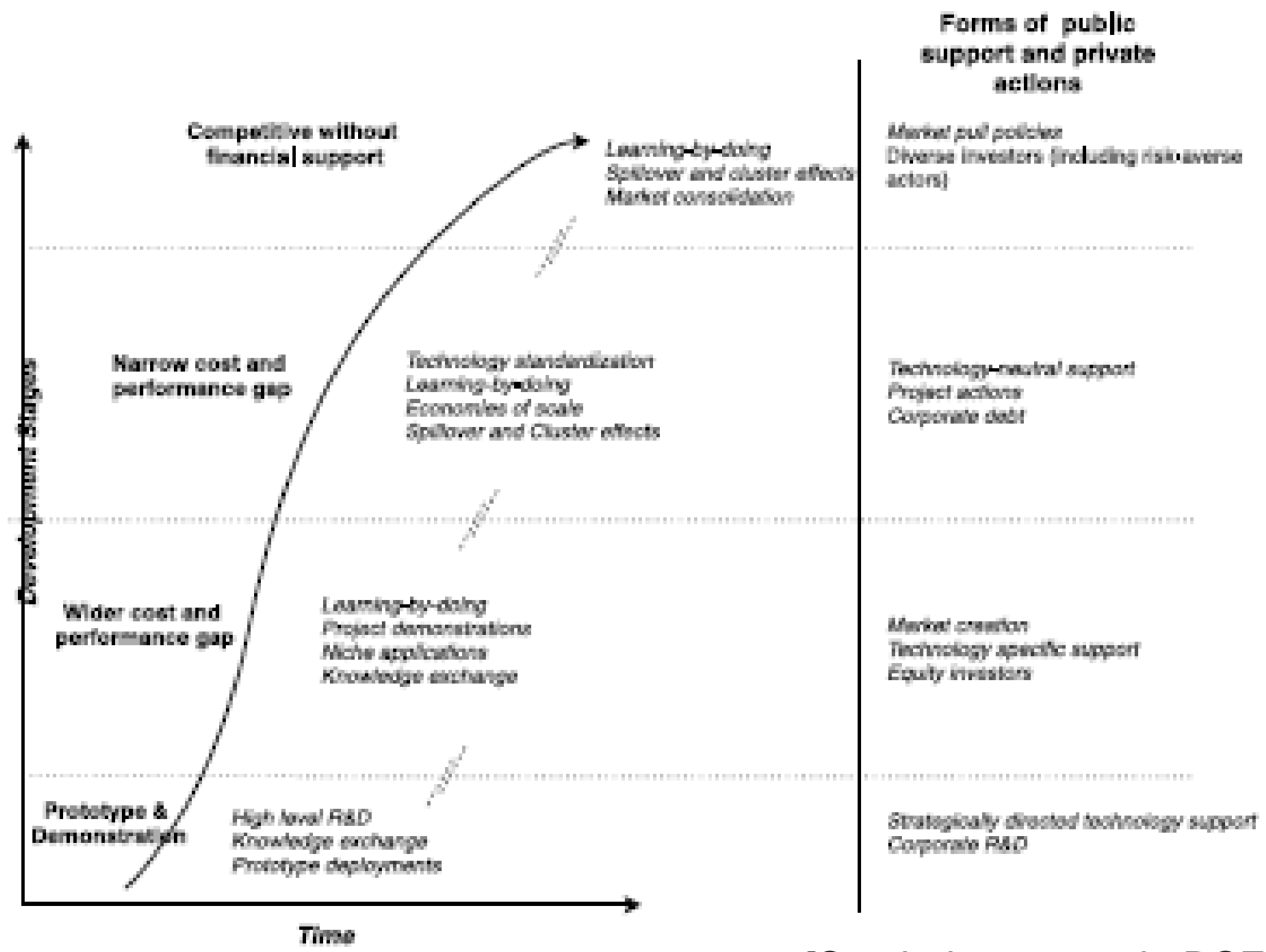
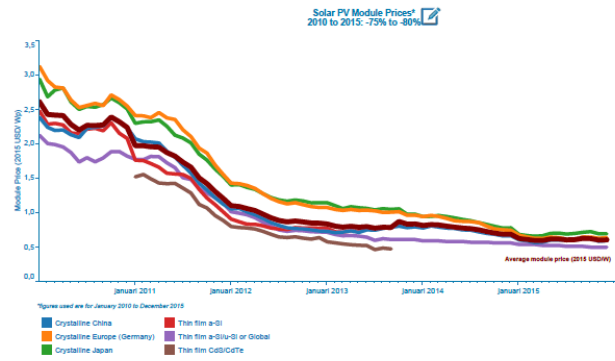
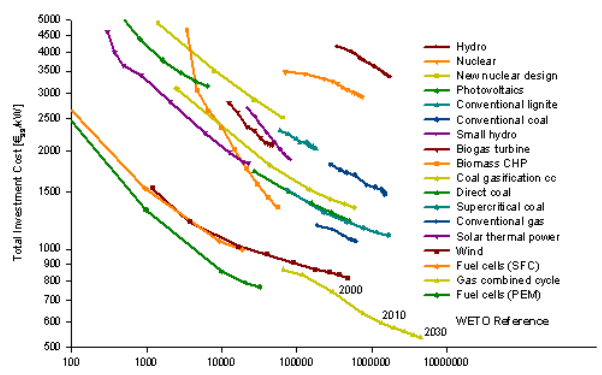
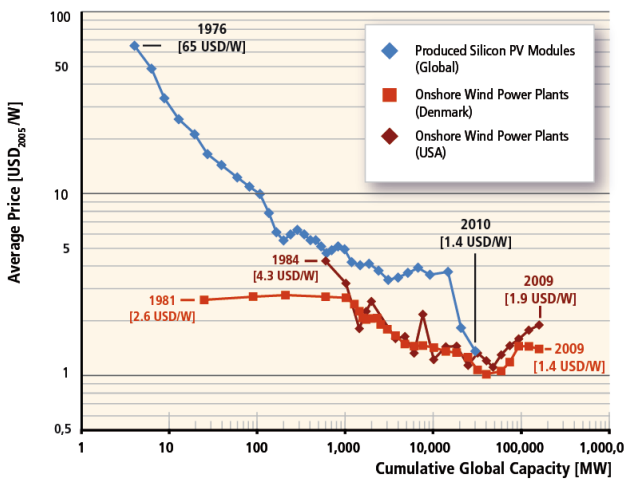


COSTS OF A SUSTAINABLE ENERGY SYSTEM

LOWER COMPARED TO A SCENARIO WITHOUT A GHG TARGET.



TECHNOLOGICAL LEARNING VS TIME...



[Santhakumar et al., RSER, 2021]

INDUSTRIAL TRANSFORMATION → ZERO CARBON FOOTPRINT DAUNTING COMPLEXITY

- › Industry ~50% of primary energy use.
- › Many options:
 - › Energy efficiency improvement existing processes
 - › New (inherently more efficient) processes
 - › Renewable feedstock (biobased industry)
 - › Renewable energy carriers (green power, green hydrogen)
 - › Carbon Capture & Storage (with BECCS negative GHG emissions)
 - › Recycling/re-use/circulair value chains
 - › Shifts in markets and products.
- › **All combined! Over roughly 3 decades; overall one investment cycle!!**
- › **Factory level, regional level, structural changes in economy and energy system**

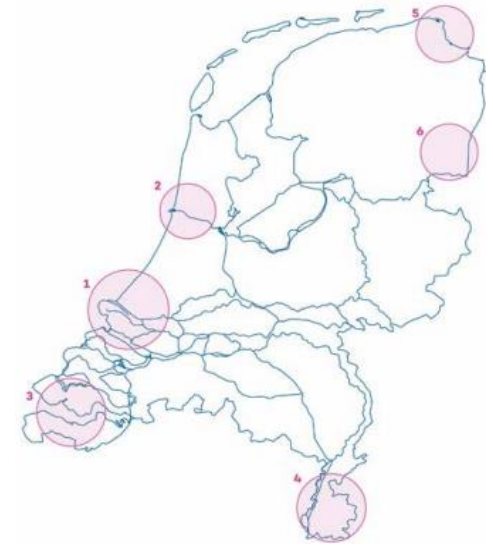
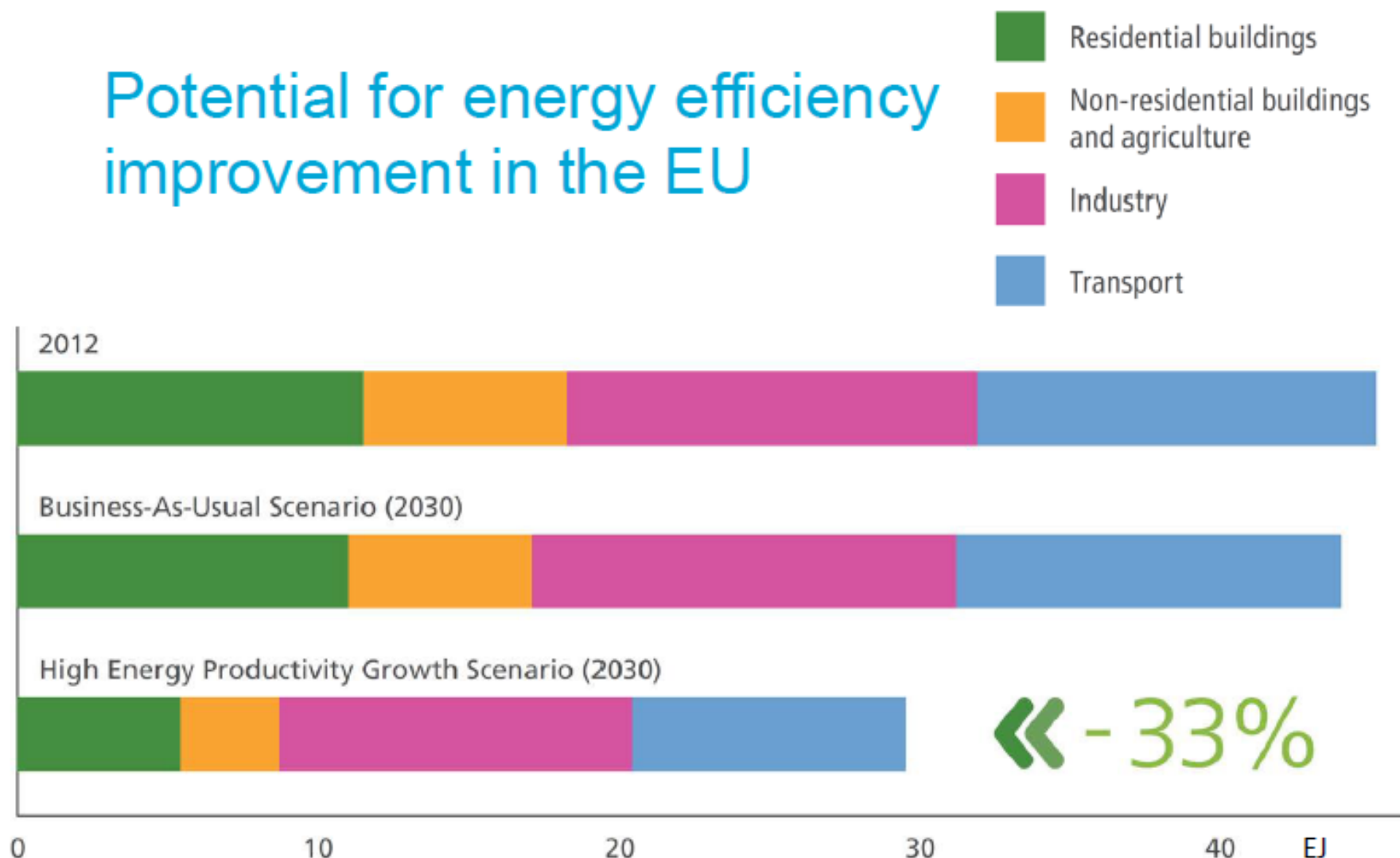


Figure 2 Location and size of the main industrial emission clusters.
1) Rotterdam - Moerdijk (16.9 Mt CO₂); 2) Noordzeekanaalgebied (12.0 Mt CO₂); 3) Zeeland - W-Brabant (7.9 Mt CO₂);
4) Chemelot (4.5 Mt CO₂); 5) Eemsdelta (0.7 Mt CO₂); 6) Emmen (0.5 Mt CO₂).^[8,9]

Potential for energy efficiency improvement in the EU



Source: K. Blok et al. The 2015 Energy Productivity and Economic Prosperity Index

WHY:

- › In 2015 world plastics production 335 Mta, only 2% of plastics closed loop recycling (Ellen McArthur)
- › EU: in 2025 55% recycling rate set for plastics, 10 Mta plastics recycled to products (Circular Plastics Alliance) - in 2030 all plastics are recyclable and >50% is recycled
- › Worldwide Industry partnership announced 1.5 billion euro initiative plastics recycling January 14, 2019

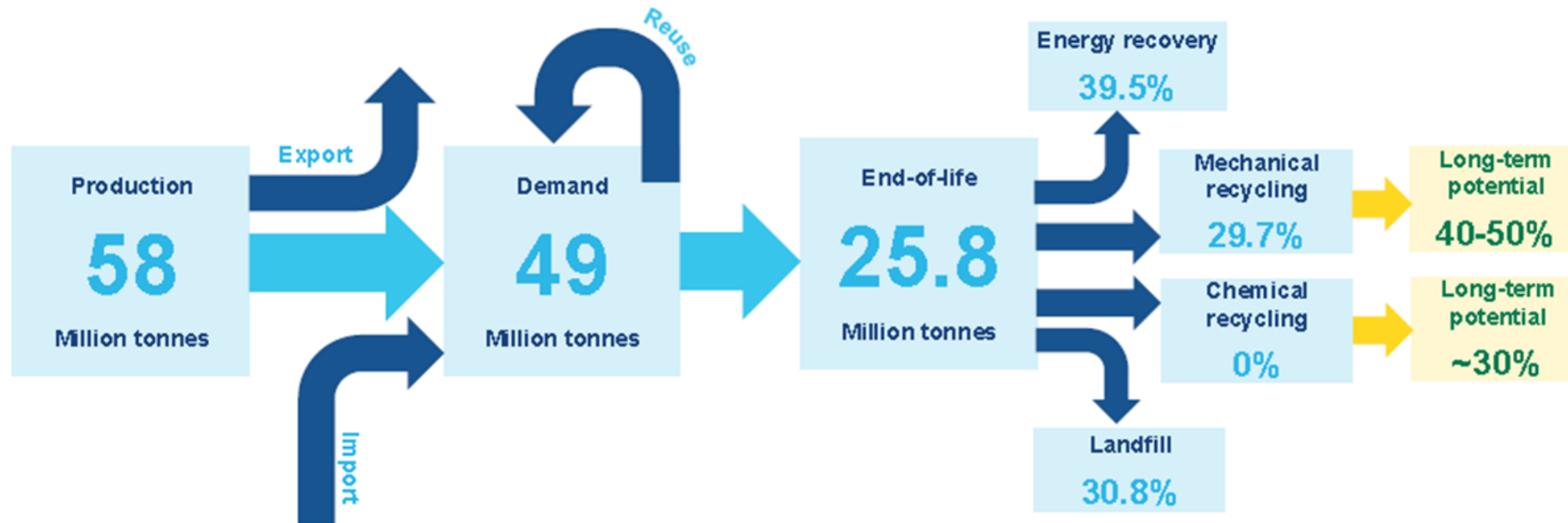


Figure 3-5 European plastics production, demand and waste treatment in 2015, including long-term potential. Team analysis based on Plastics Europe [15], Accenture [14].

Power to chemicals

Electro-organic synthesis

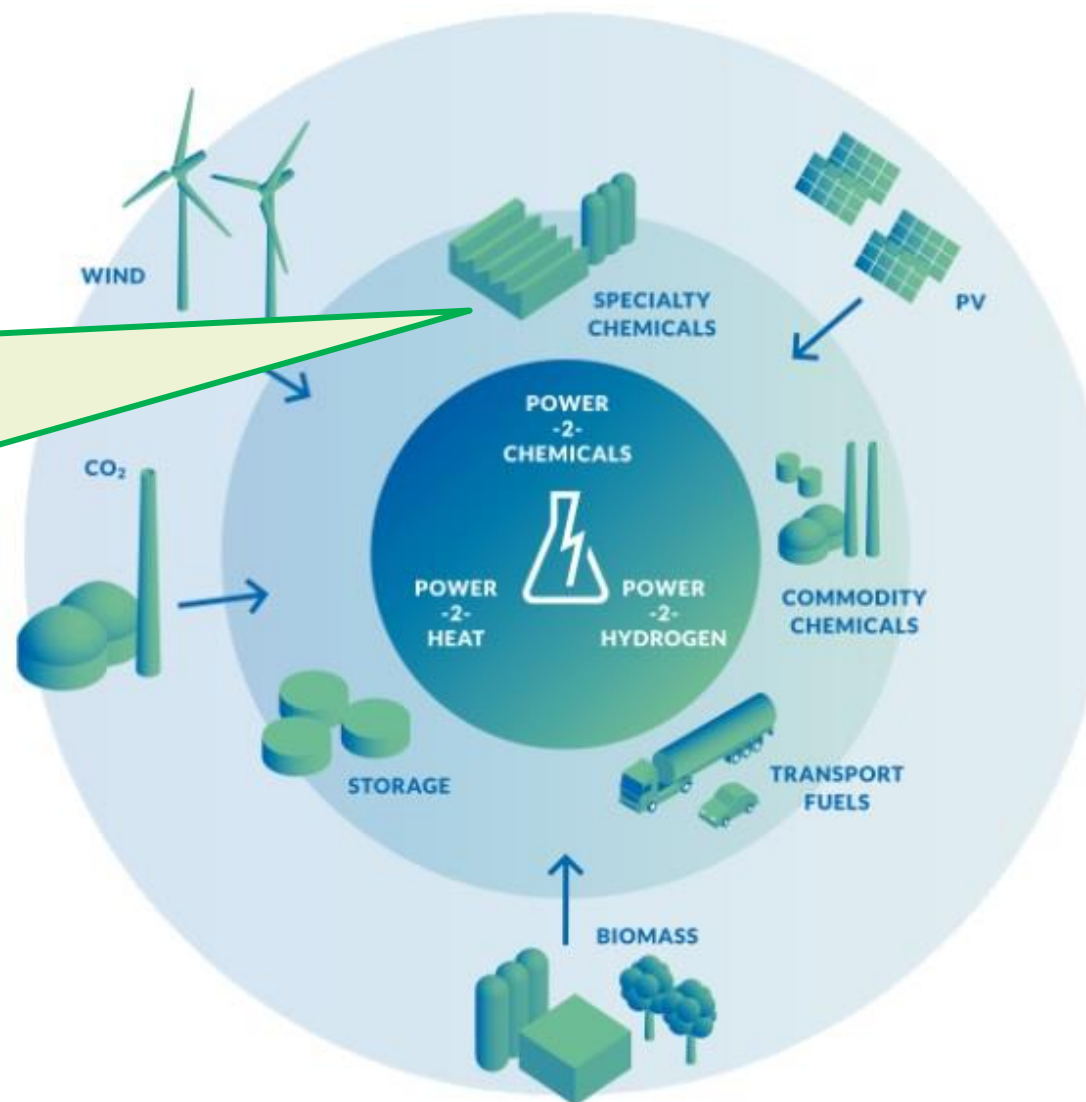
CO₂ electro-reduction

Electro-oxidation

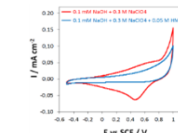
Electro-reduction

- ✓ Oxidation of furfural
- ✓ Oxidation of hydroxymethylfuran
- ✓ Oxidation of alcohols

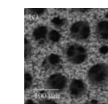
- ✓ Reduction of furfural
- ✓ Reduction of hydroxymethylfuran
- ✓ Reductive amination
- ✓ Reduction of oxygen



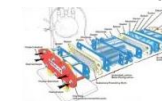
Key technical & scientific enablers:



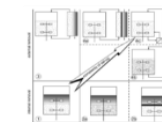
Electrochemistry



(3D structured)
electro-catalysts



Reactor design

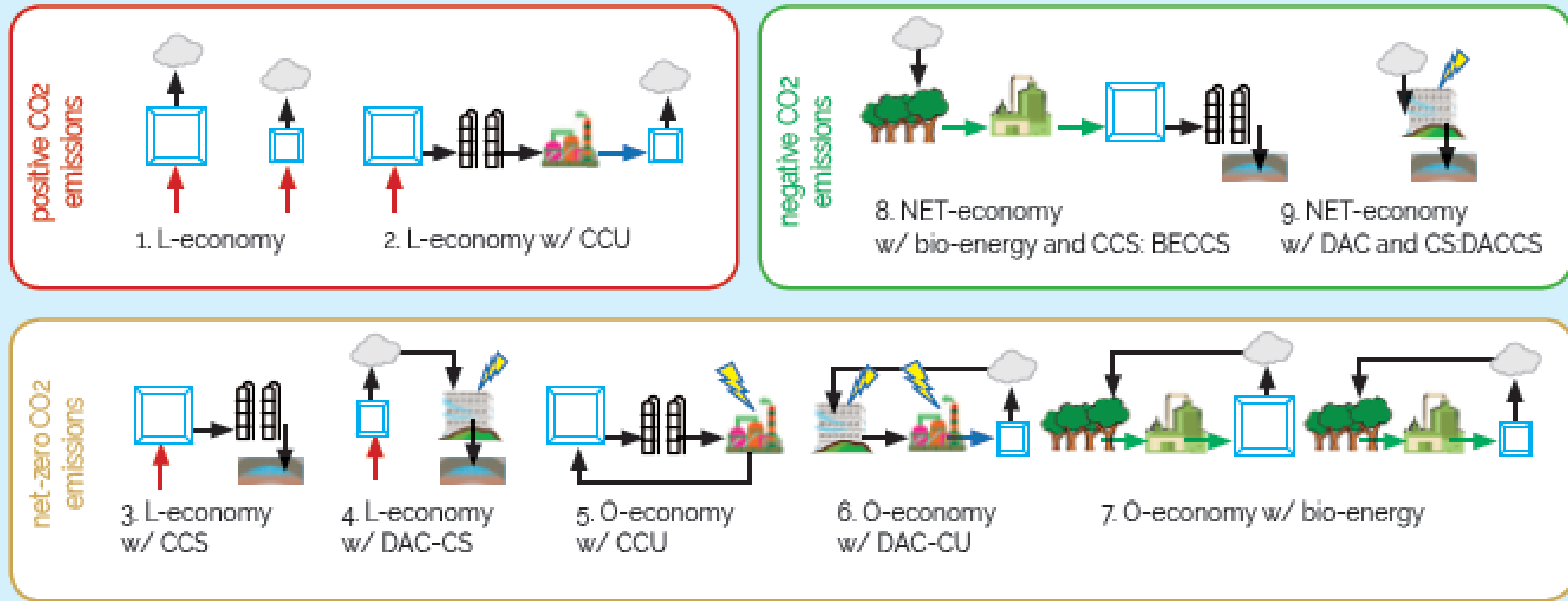


Downstream
processing



Integrated design
& Economics

BASIC CARBON BALANCES OF CCU WITH DIRECT AIR CAPTURE (DAC), BECCS AND COMBINATIONS



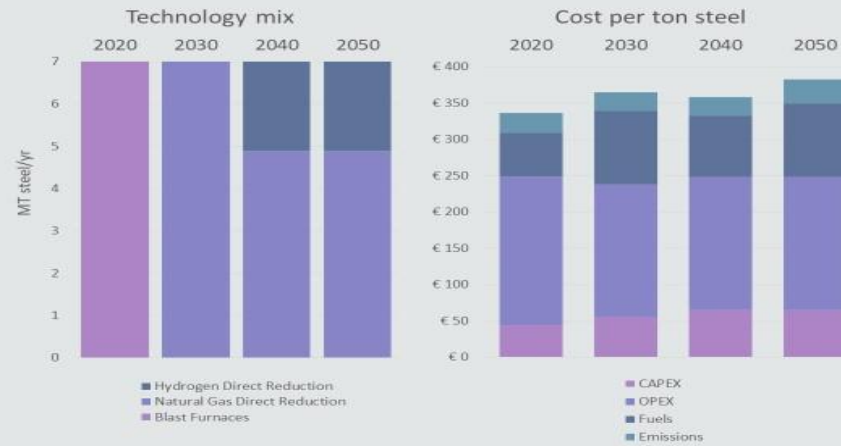
[SAPEA, 2018]

Major opportunities for future low carbon chemical industry

Reference scenario: Open optimisation by IESA-Opt

Sector effects

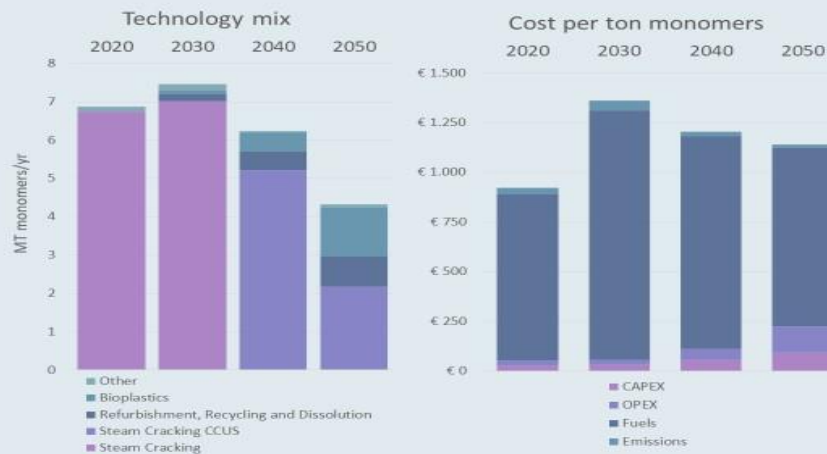
Steel



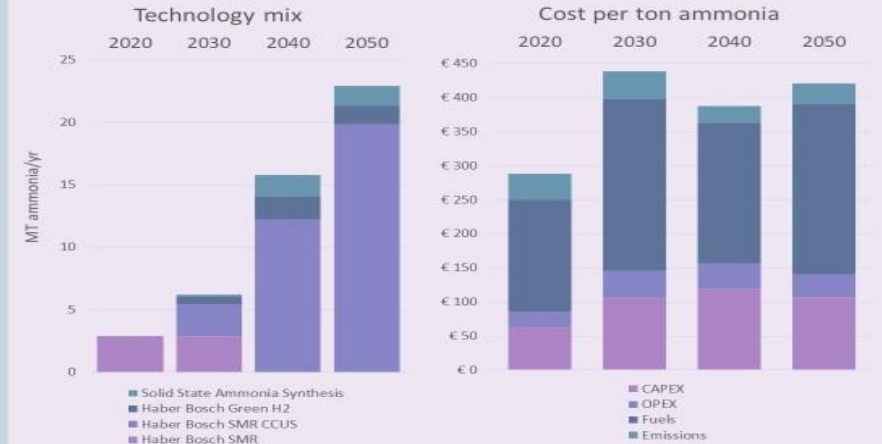
Refining



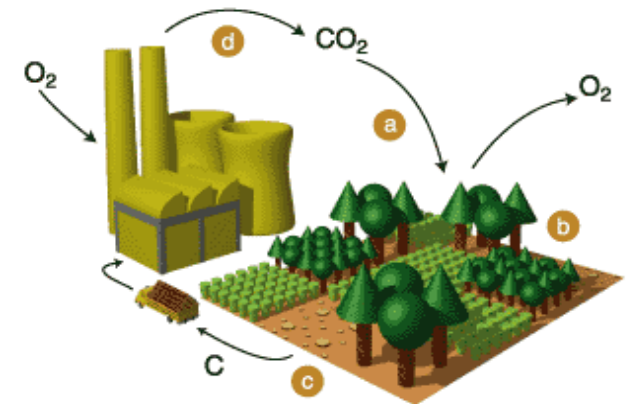
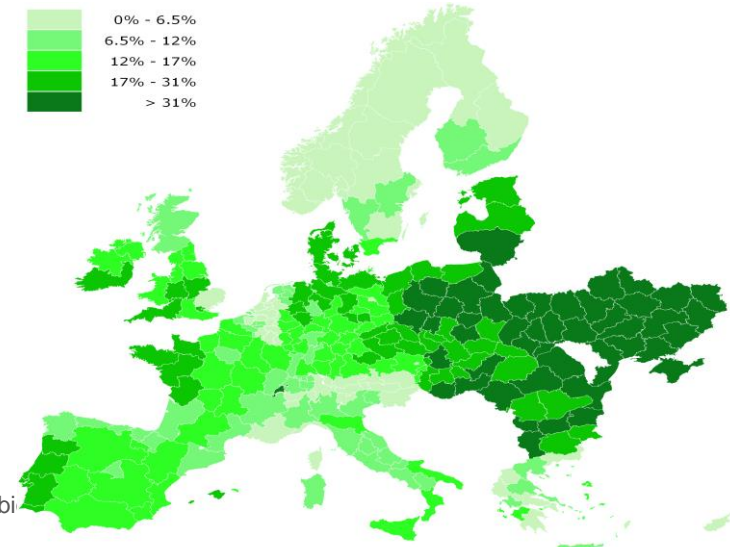
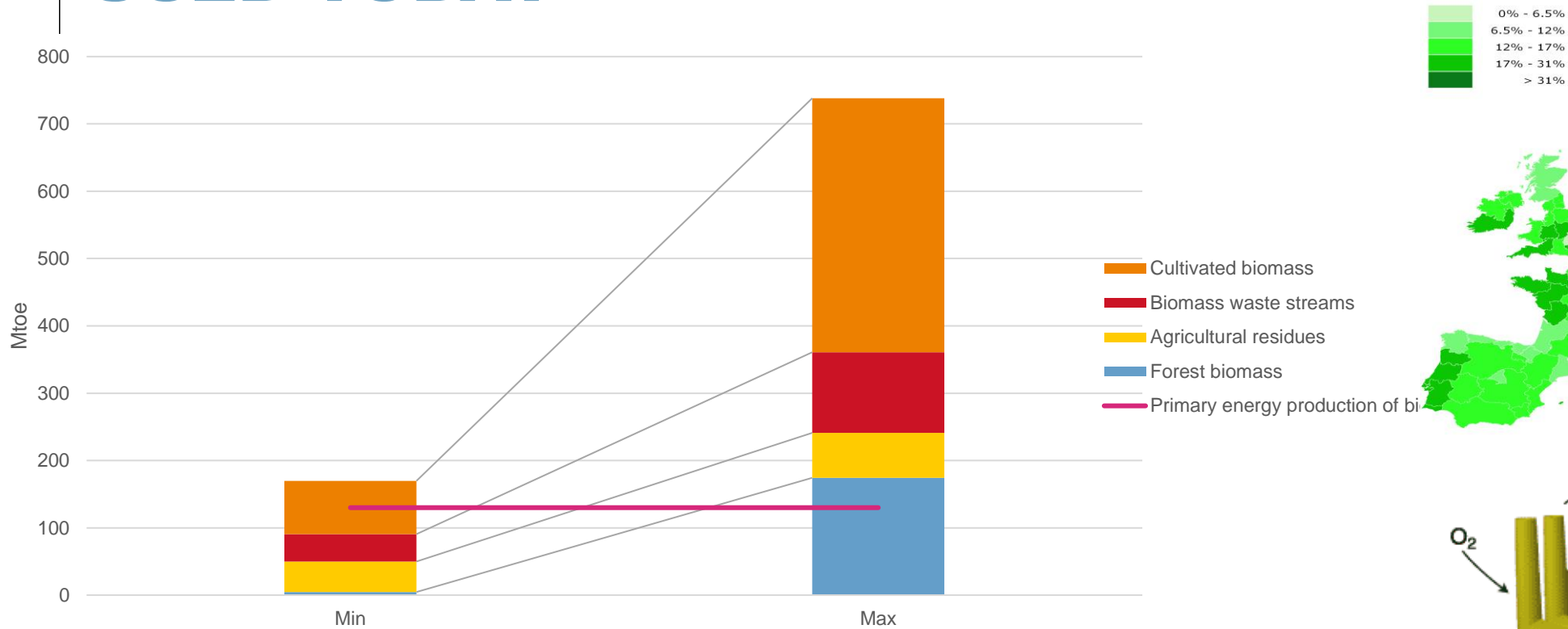
Plastics



Ammonia



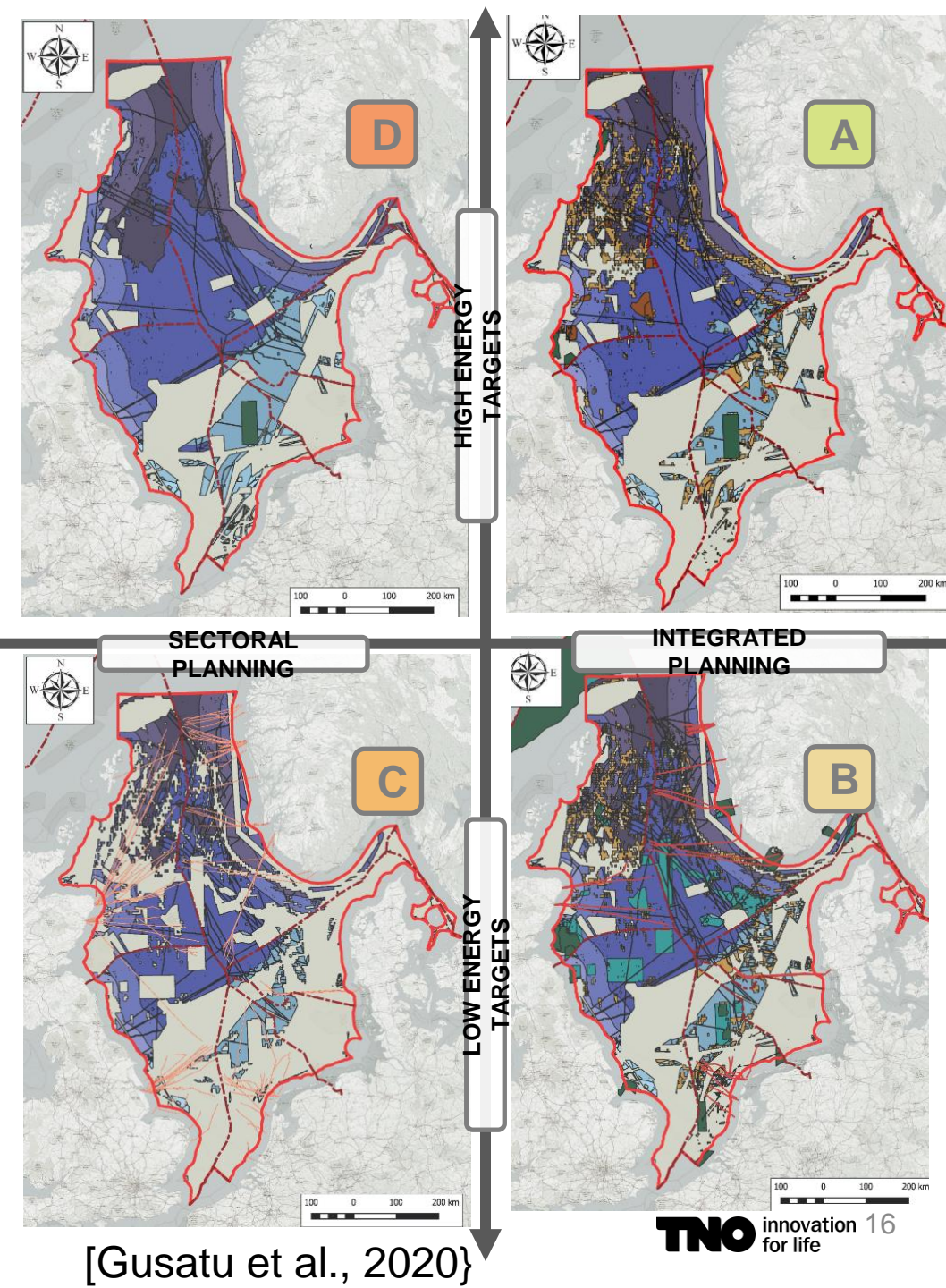
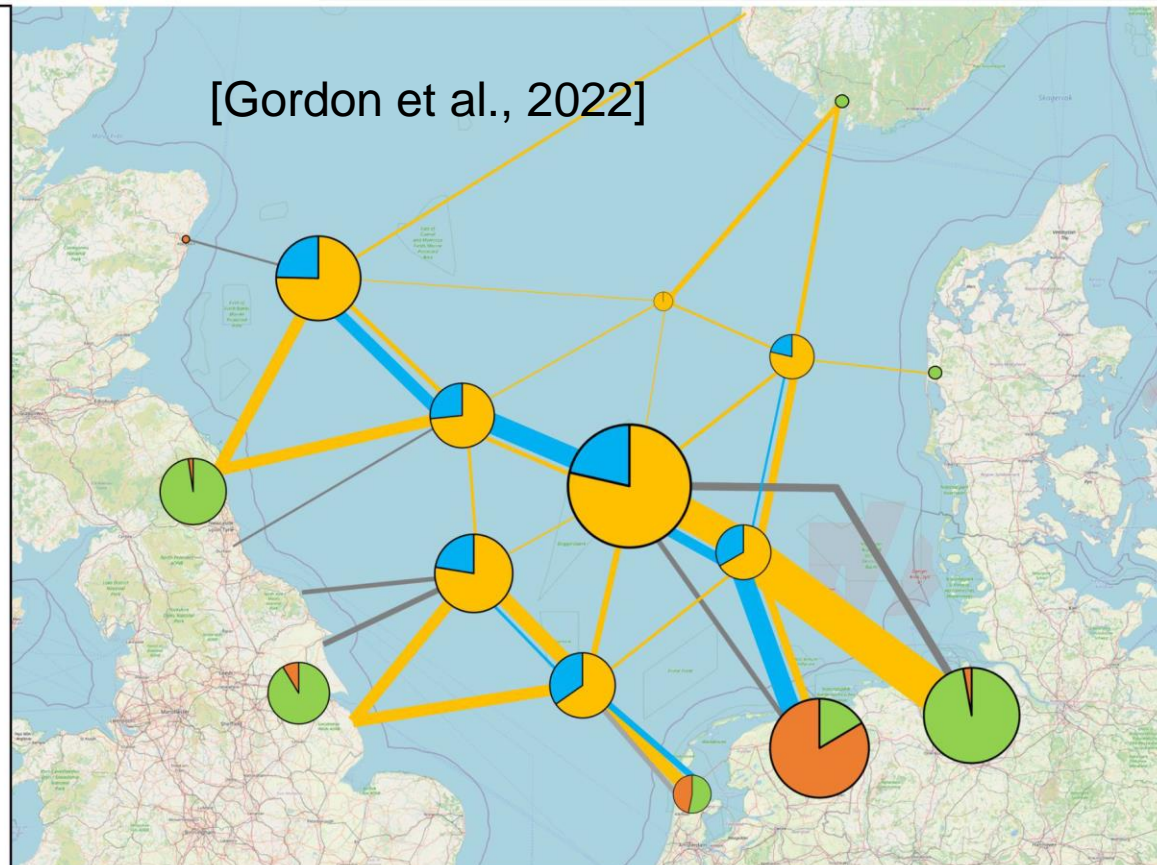
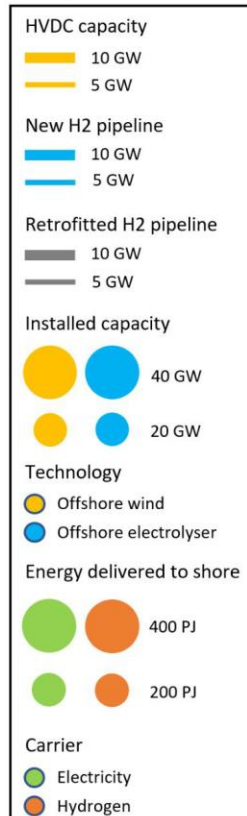
BIOMASS POTENTIALS EU28 IN 2050; 7-30 EJ COMPARED TO 68 EJ; TOTAL PRIMARY ENERGY USED TODAY



[Faaij, Bioenergy Europe, 2018]

NORTH SEA REGION: BIGGEST LIVING ENERGY TRANSITION LABORATORY IN THE WORLD

source: Tennet



FURTHER ENERGY SYSTEM INTEGRATION...

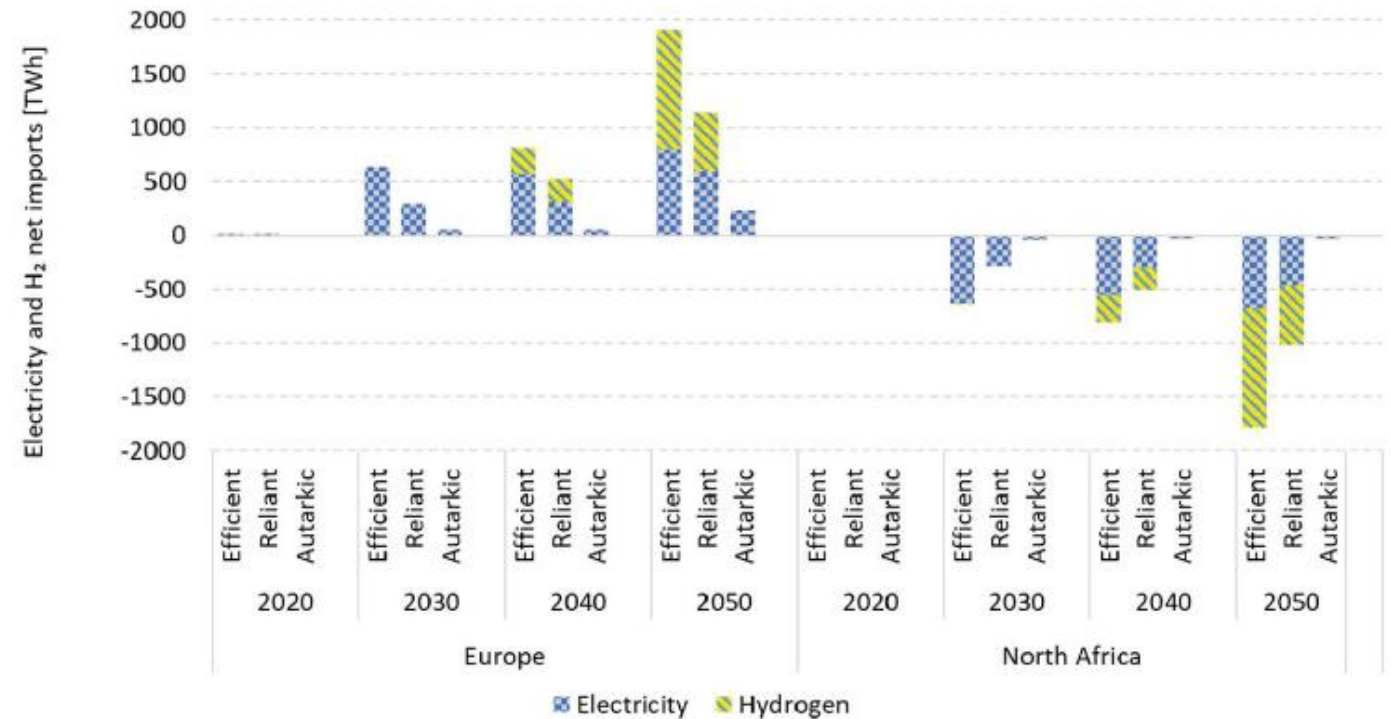
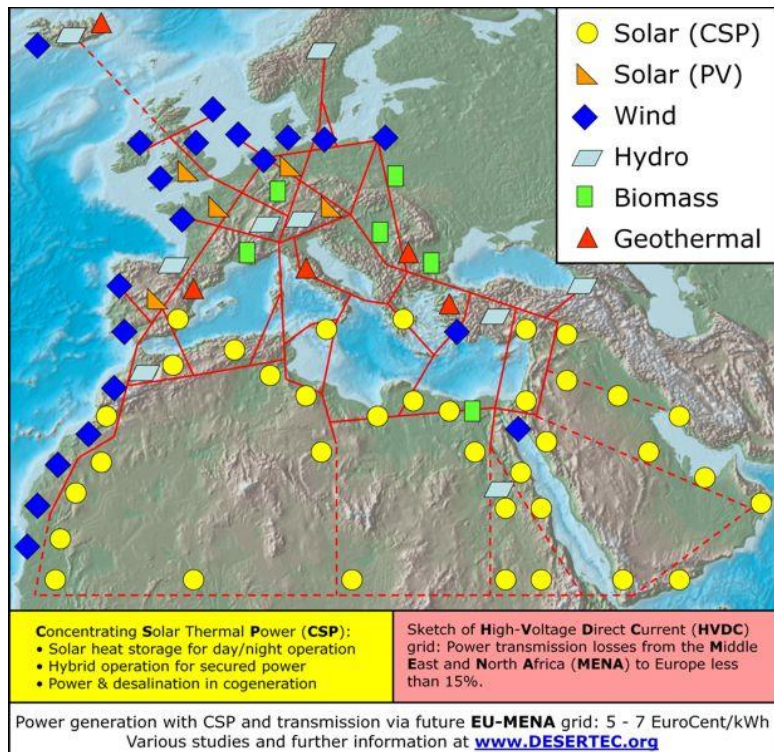


Fig. 4. Projections with TIAM-ECN for trade of electricity and hydrogen.

Zwaan et al, Energy Policy 2021, TIAM model

SOME KEY OBSERVATIONS

- › Rapid response possibilities (within one year) to lower use of fossil fuels are overall considerable: efficiency and behaviour, fuel shifts power sector, diversification of imports (LNG), likely response of fossil fuel exporters. Counterresponse from Russia on the global market also likely.
- › The agreed targets (EU Green Deal, fit for 55) for 2030 are sufficient to terminate the need for Russian fossil energy exports (but dependency on imports overall does remain).
- › Acceleration of parts of the package is possible for e.g.: built environment, biobased options, more intermittent power, efficiency in industry
- › This capacity to accelerate has long term value and will lower costs of the transition.
- › Sustainable energy system can be much more resilient to energy supply risks than today; macro-economic benefits are very large.
- › The energy transition is fully competitive at current fossil energy price levels and will structurally reduce costs of energy.