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LEADING THE LOW-CARBON TRANSITION

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Panel 4: Technology & Systems

Decarbonization pathways - scenarios and electrification options - II

Concepts and pathways towards a carbon-neutral heavy industry in North Rhine-Westphalia

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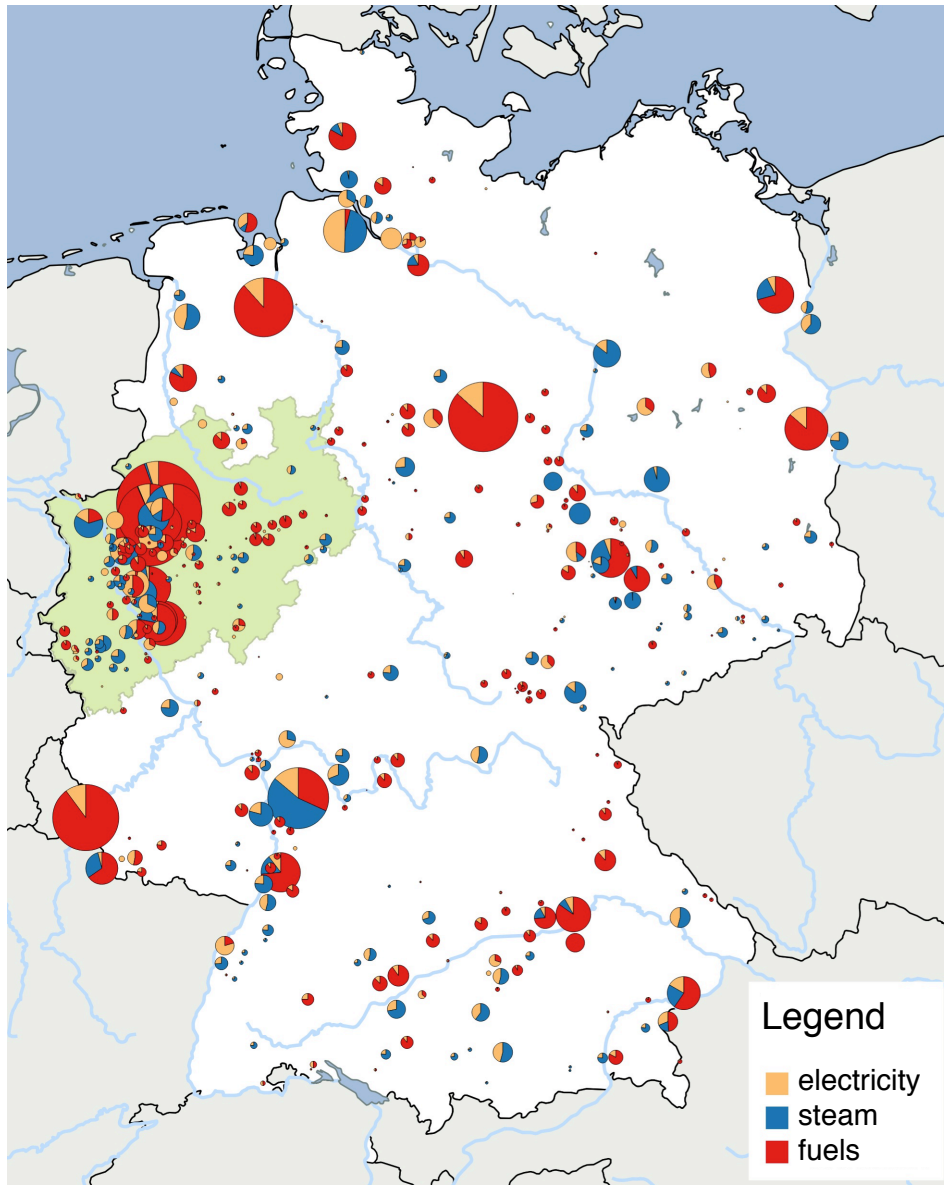


**Wuppertal
Institut**

North Rhine-Westphalia (NRW)

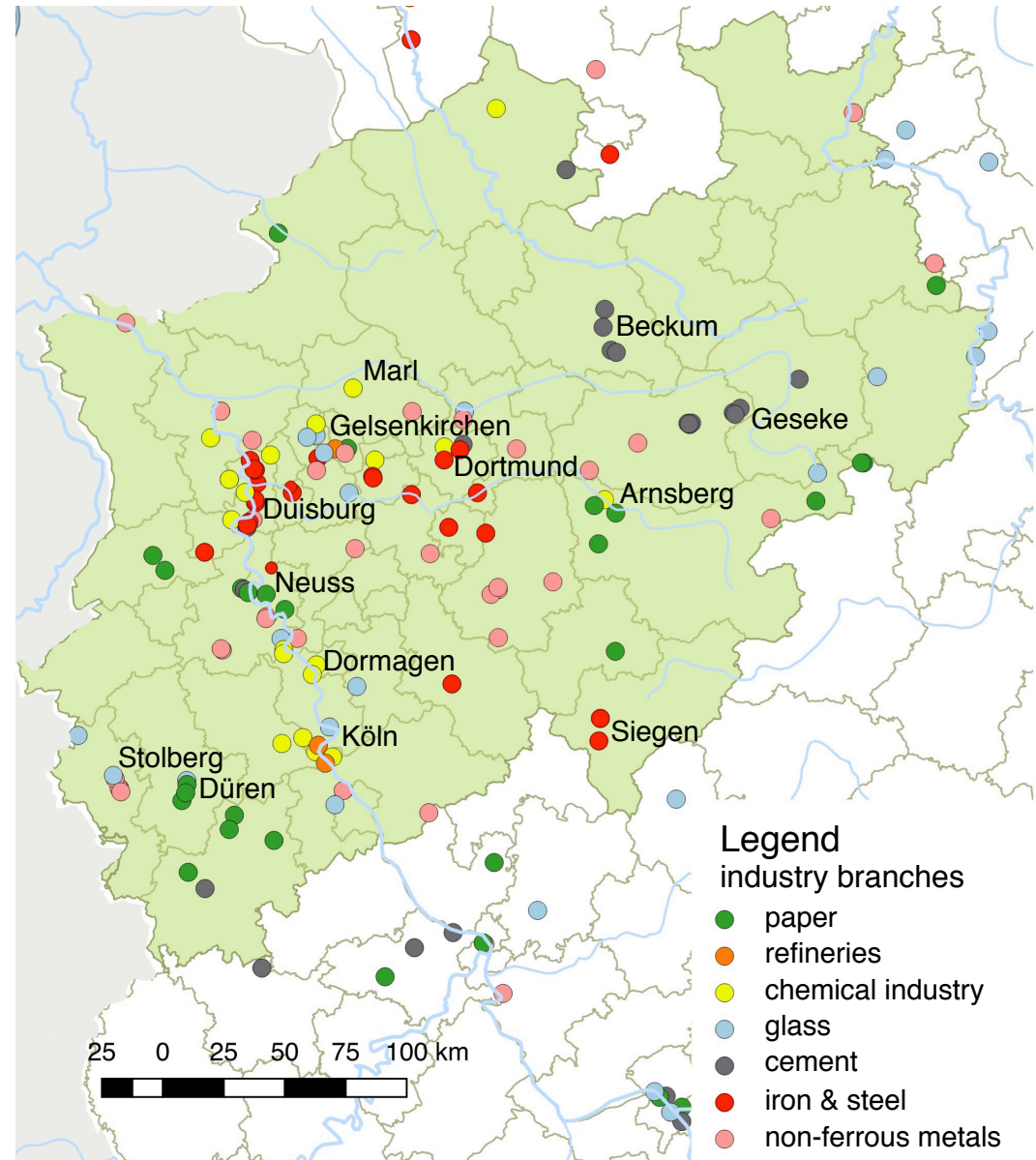
Home of Germany's energy intensive industries (EII)

Energy demand of EII in Germany



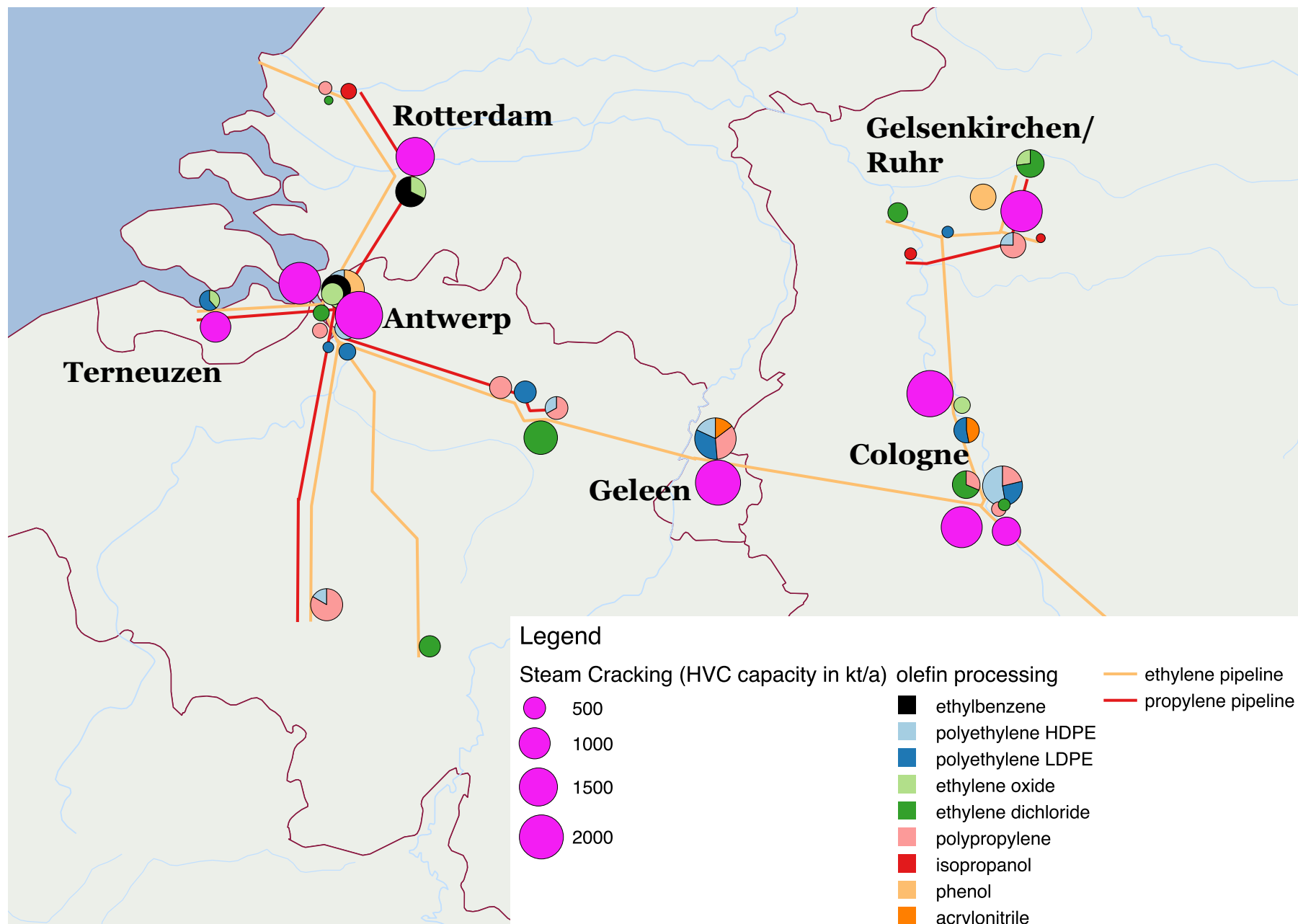
Source: own maps.

EII sites in NRW



Cross-border perspective: Petrochemical triangle

Rotterdam – Flanders – Rhine-Ruhr



Source: own map.

The results presented are part of a study on behalf of European Climate Foundation (ECF) dealing with infrastructure issues in connection to the decarbonisation of heavy industry in NRW.

Hypothesis: Infrastructure matters.

Viability of heavy industry clusters strongly depends on infrastructures.

Even if they need new production stocks in the course of decarbonisation today's clusters can make worth of their existing infrastructures.

Decarbonisation of heavy industries should be an important issue not only in industrial policy but also in regional policy and infrastructure planning.

Two step approach:

- Bottom-up scenario analysis
- Infrastructure analysis

The **Scenario exercise** reveals **prototypical pictures** of a future decarbonised heavy industry in NRW.

No strong ambition in direction of a circular economy.

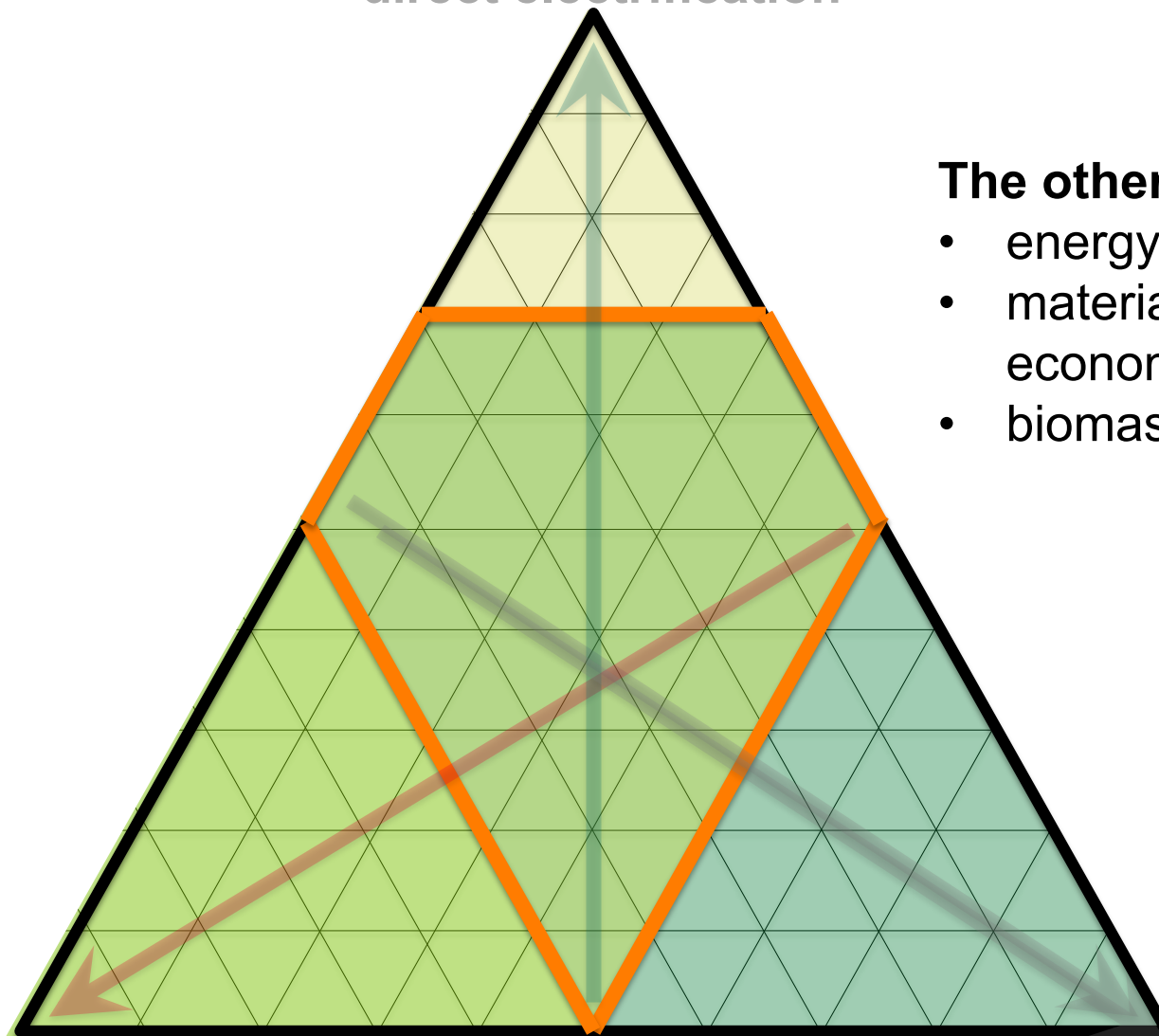
The **spatial infrastructure analysis**

- hints at potential relevance of **single technologies and infrastructures**,
- discusses **interdependencies between heavy industry and transport fuel supply**,
- allows for the discussion of **potential clustering of sites**

direct electrification

The other crucial strategies:

- energy efficiency
- material efficiency / circular economy
- biomass

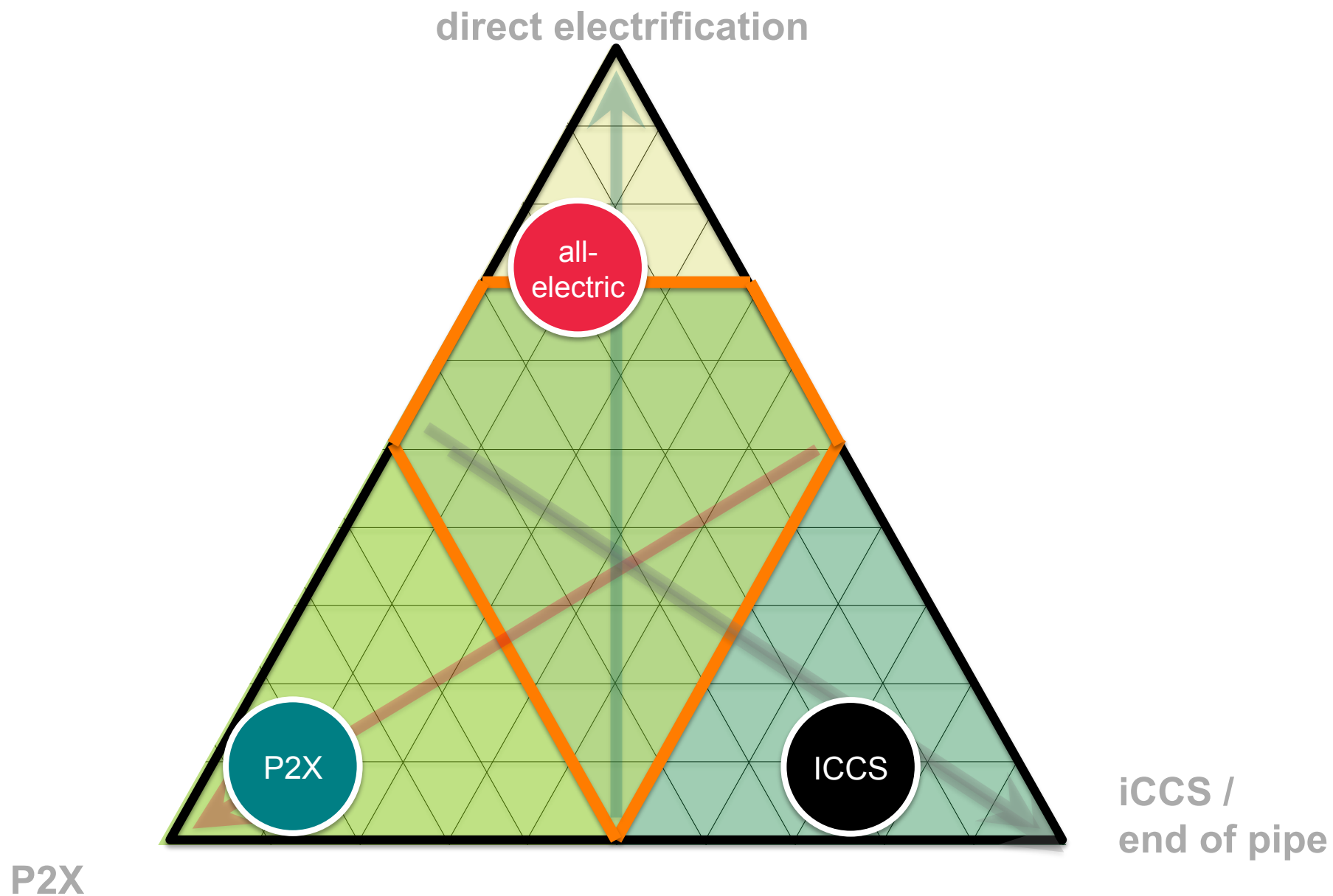


P2X

iCCS /
end of pipe

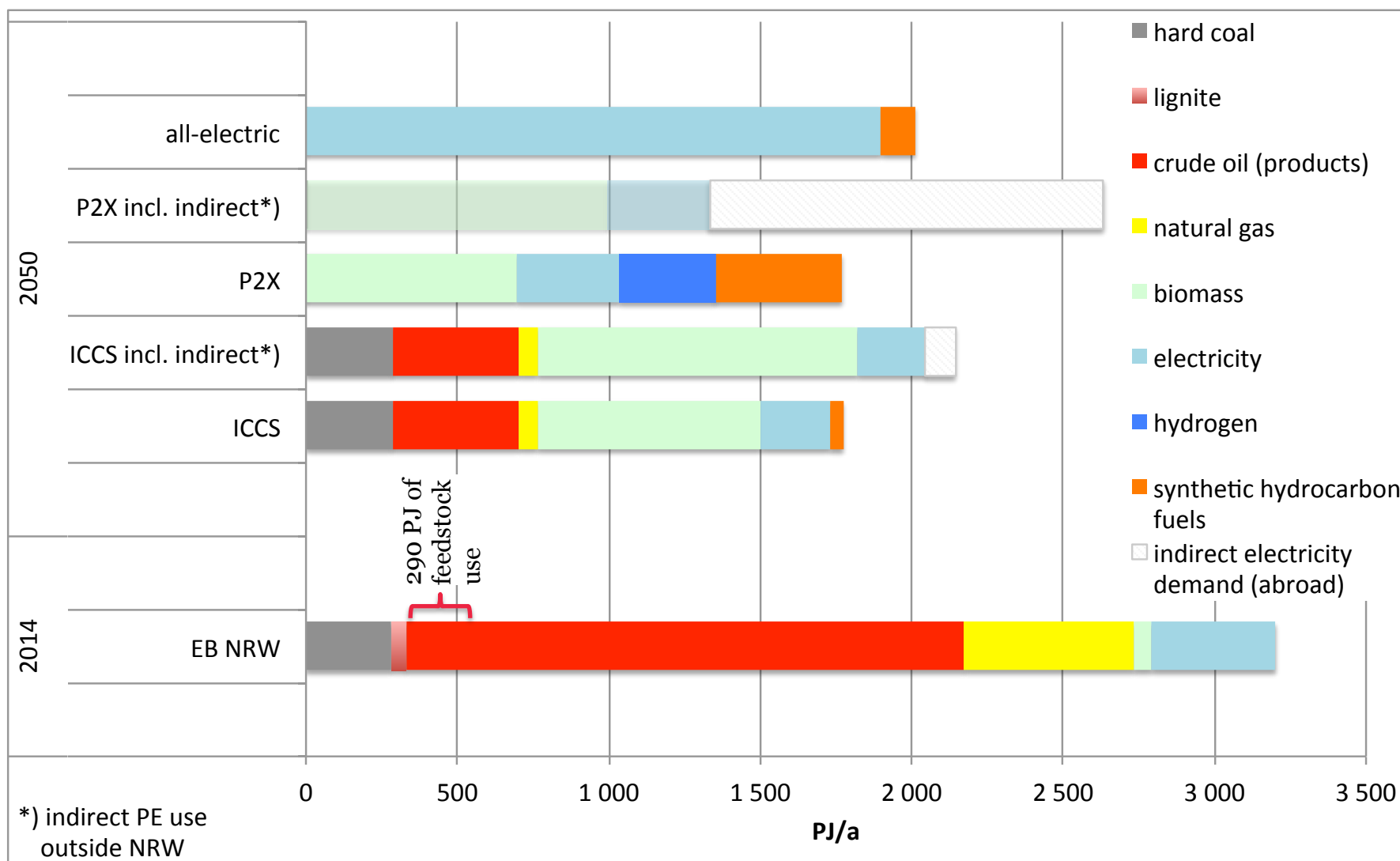
Three prototypical scenarios

	<i>iCCS</i>	<i>PtX Import</i>	<i>all-electric</i>
TRANSPORT	biofuels	synthetic fuels import	electric motors
BUILDINGS	mixed system: heat pumps, decentralised CHP, bio etc.		
STEEL	coal+CCS	H-DRI (H2 import)	H-DRI
PLASTICS	Steam Cracking+CCS	PtC via methanol (import)	PtC via methanol
INDUSTRY OVENS	fossil fuel + CCS	biomethane (import)	electric ovens
STEAM	fossil+CCS / biomethane		PtH



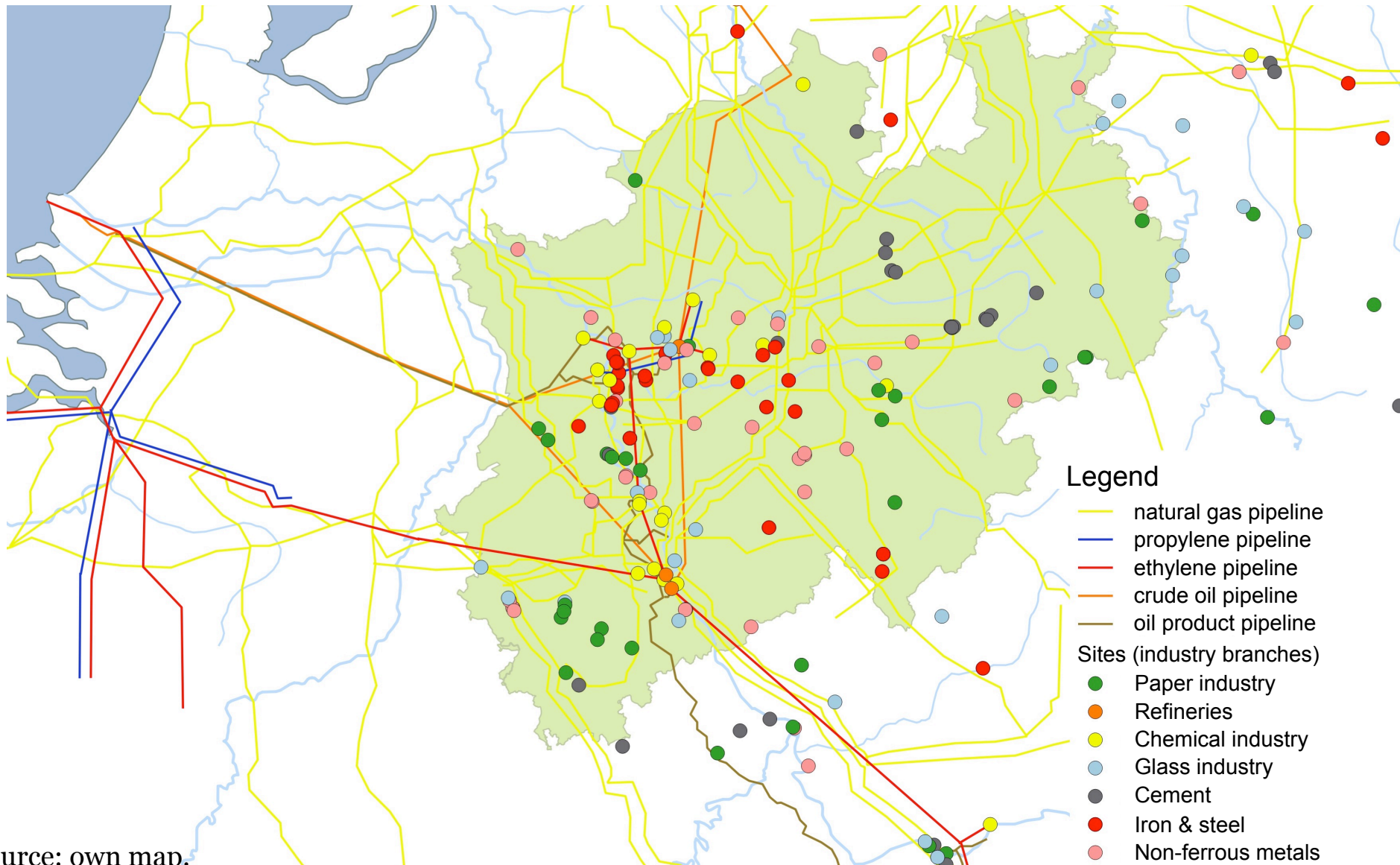
Scenario analysis: Energy needed

Primary energy balance of the scenarios (electricity is regarded as PE here)



Source: own figure, derived from IT.NRW (2017) and own calculations.

Infrastructure analysis

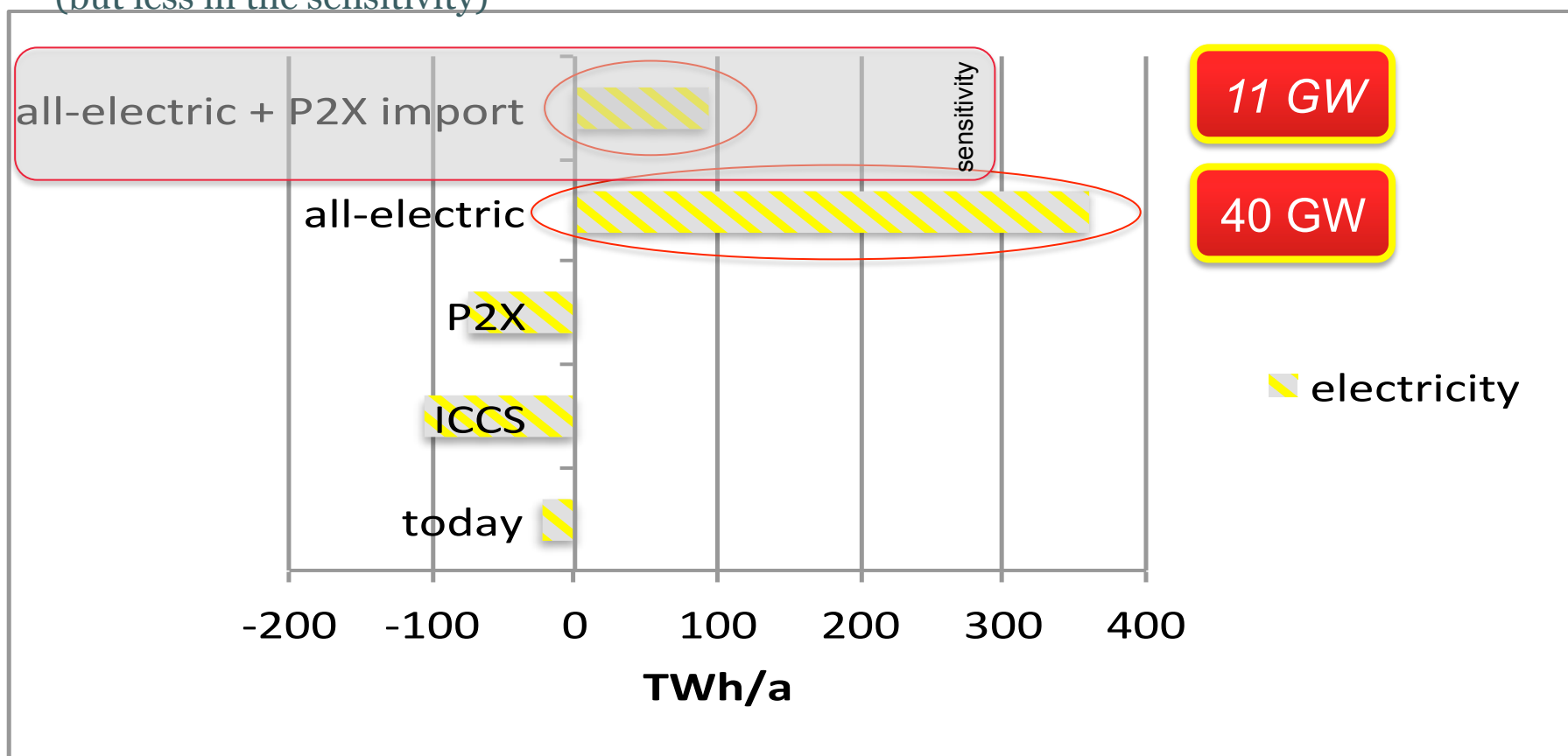


Source: own map.

Infrastructure needs for import/export

NRW net balance electricity

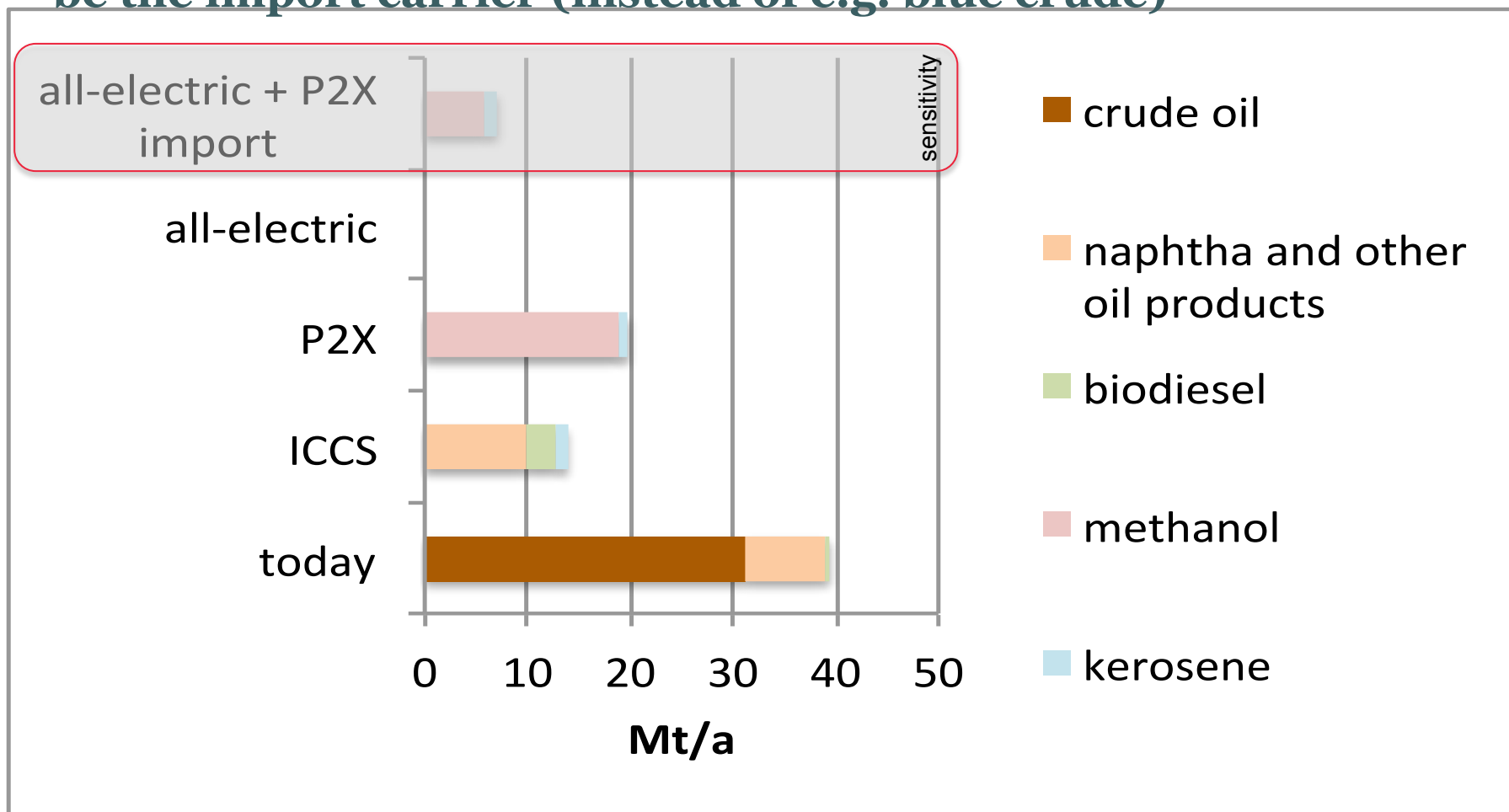
- **Net exchange increases in all scenarios** (but maximum extension of generation capacities within NRW assumed)
- **At least in the all-electric scenario massive grid investments needed!**
(but less in the sensitivity)



Source: own figure based on IT.NRW (2017) and own calculations.

Infrastructure needs for import/export NRW net balance liquid energy carriers

- Only little shortages indicated
- Conversion of crude oil pipelines could be needed if methanol would be the import carrier (instead of e.g. blue crude)

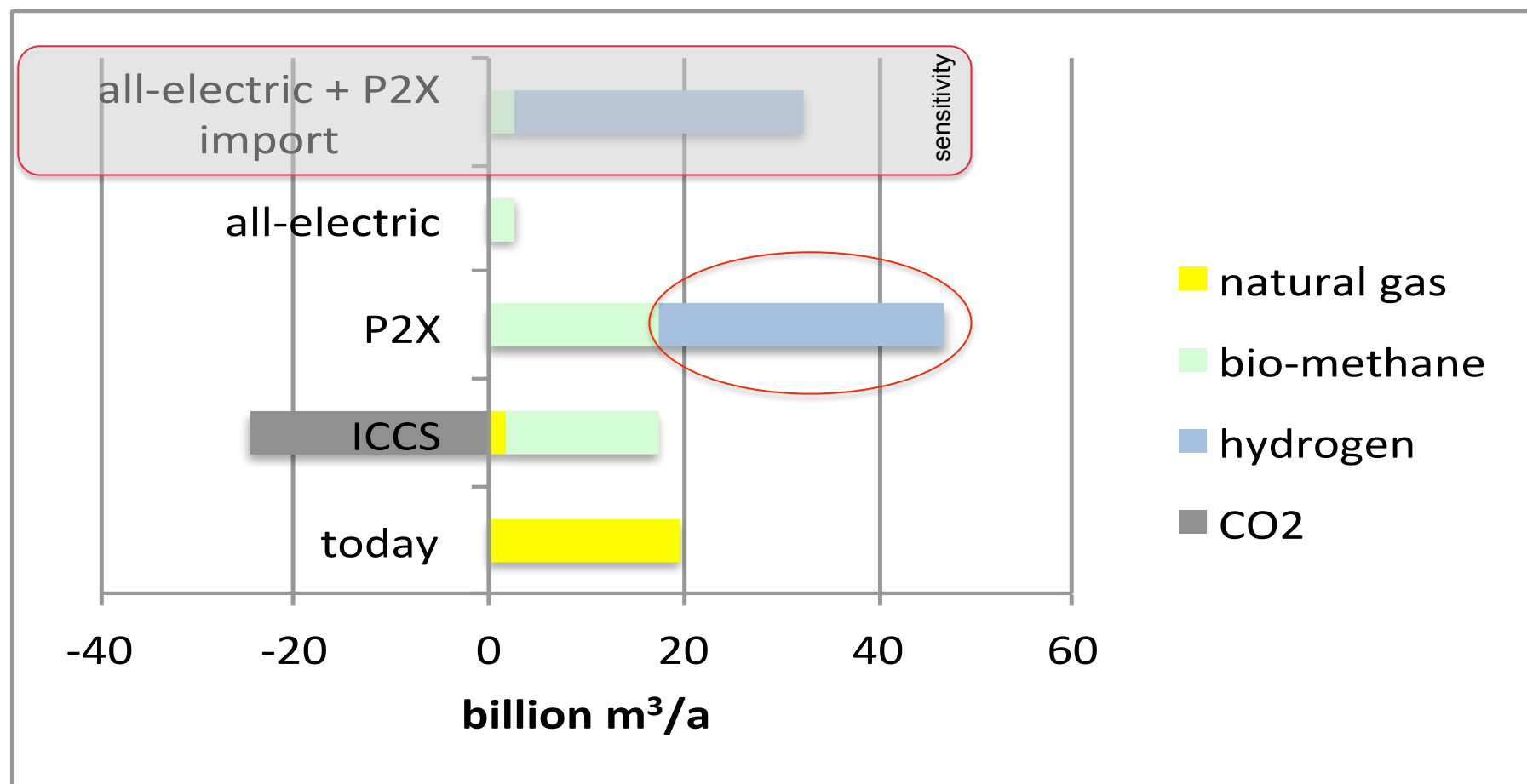


Source: own figure based on IT.NRW (2017) and own calculations.

Infrastructure needs for import/export

NRW net balance for gas imports

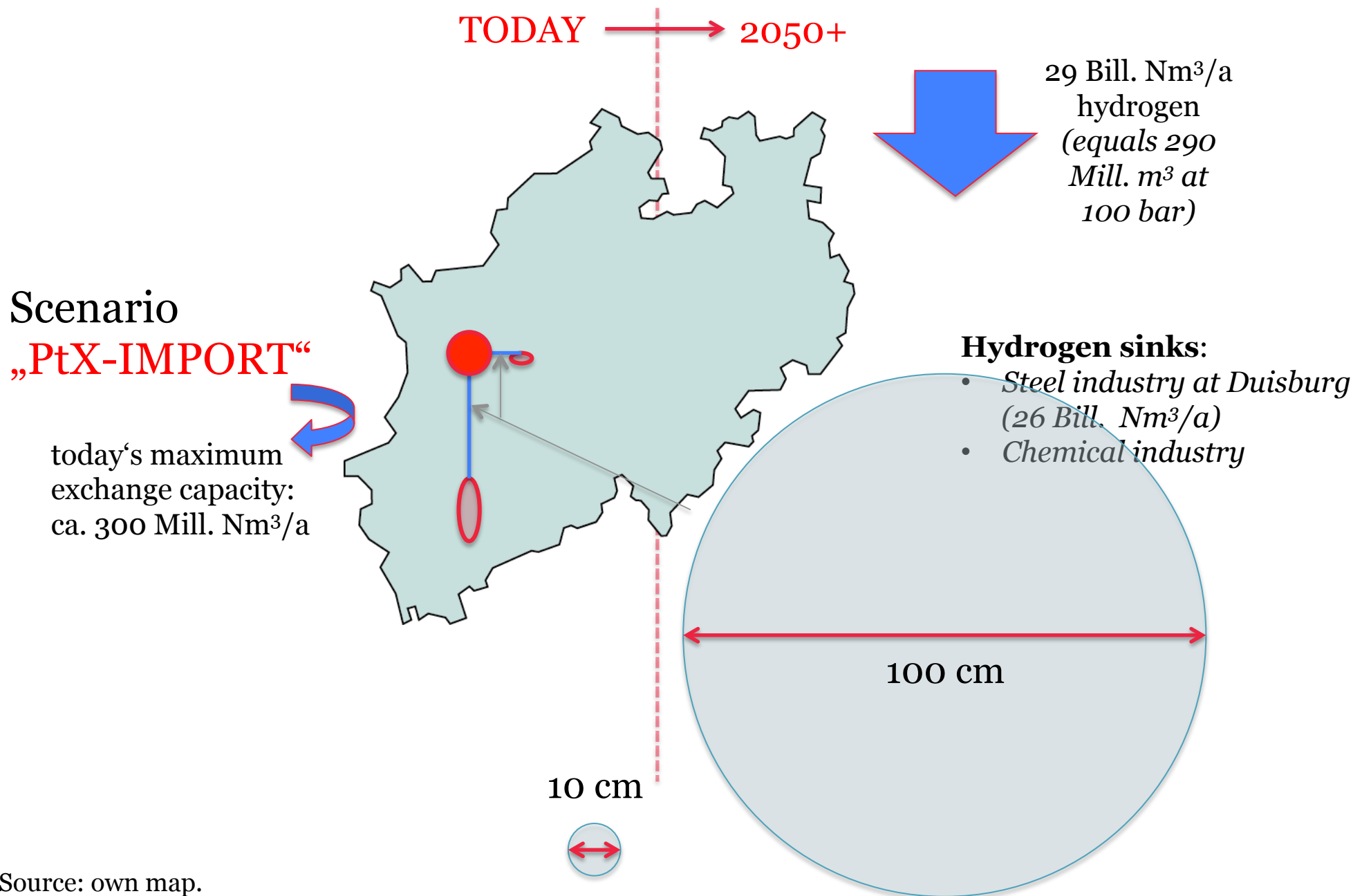
- **P2X: new H₂ pipeline required (conversion of natural gas pipes?)**
- **iCCS: CO₂ transport pipe required?**



Source: own figure based on IT.NRW (2017) and own calculations.

Infrastructure needs for import/export today vs. future

Hydrogen in the *P2X* scenario



Source: own map.

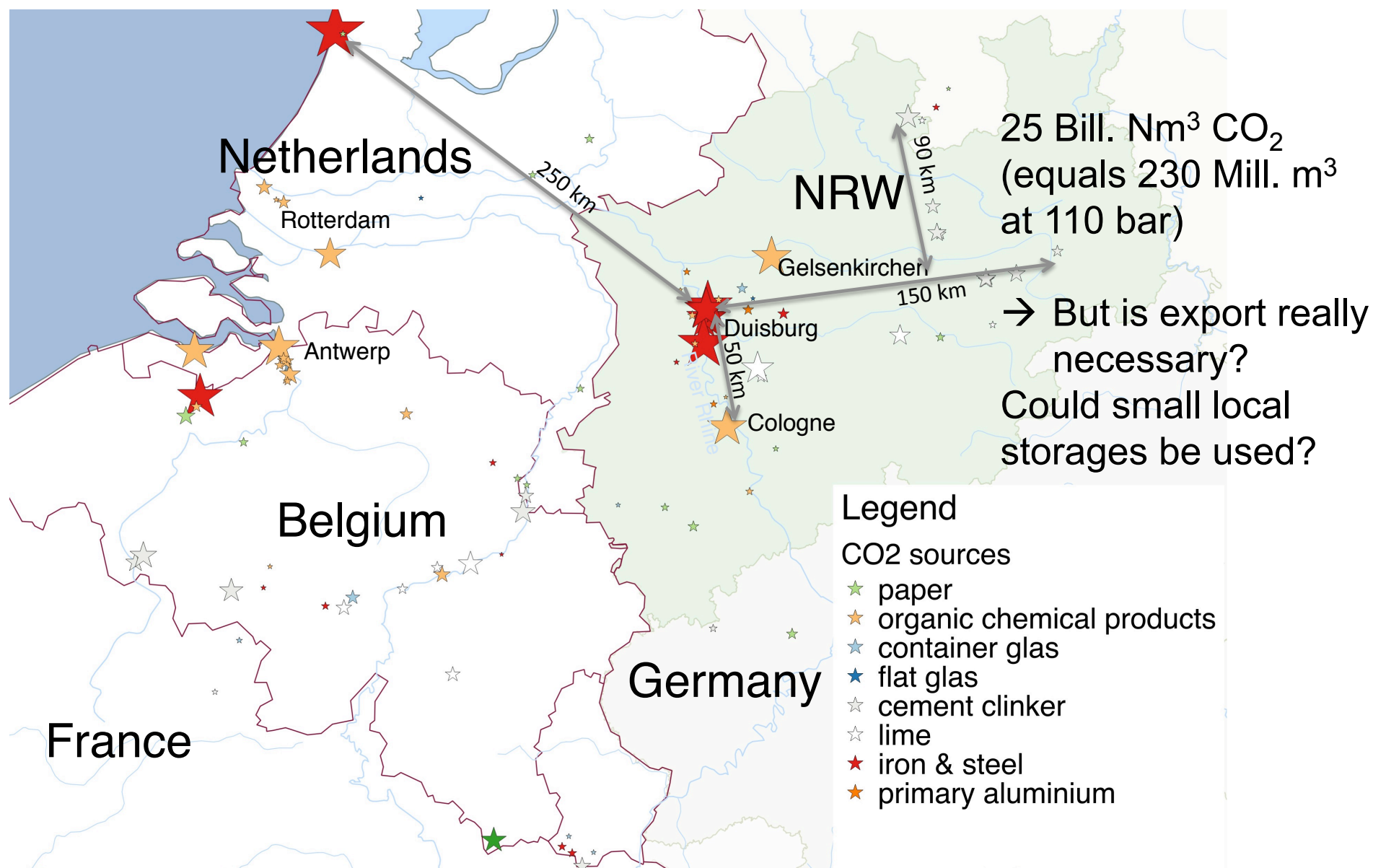
Infrastructure needs for import/export today vs. future

Hydrogen in the *P2X* scenario



Source: own map.

Infrastructure needs for import/export today vs. future CO₂ in the iCCS scenario



Source: own map.

Electricity:

- Direct electrification requires an EU wide massive extension of renewable electricity generation.
- For NRW a massive grid extension to the West and North of NRW is needed.

Oil

- The infrastructure for hydrocarbon liquids is sufficient but would have to be converted if the energy industry went for a new reference energy carrier like methanol.
- An all-electric world would do without this infrastructure.

Gas

- The natural gas grid is sufficient to carry synthetic methane.
- CO₂ pipelines are needed in the CCS case or to carry industrial CO₂ to CCU locations.
- Hydrogen import could massively reduce the need to import electricity.

Need of more differentiated scenarios

- Technology needs, innovation roadmaps
- Investment needs and pathways

Co-evolution of heavy industry and energy system

- Timing
- interdependancies

Possible Strategies

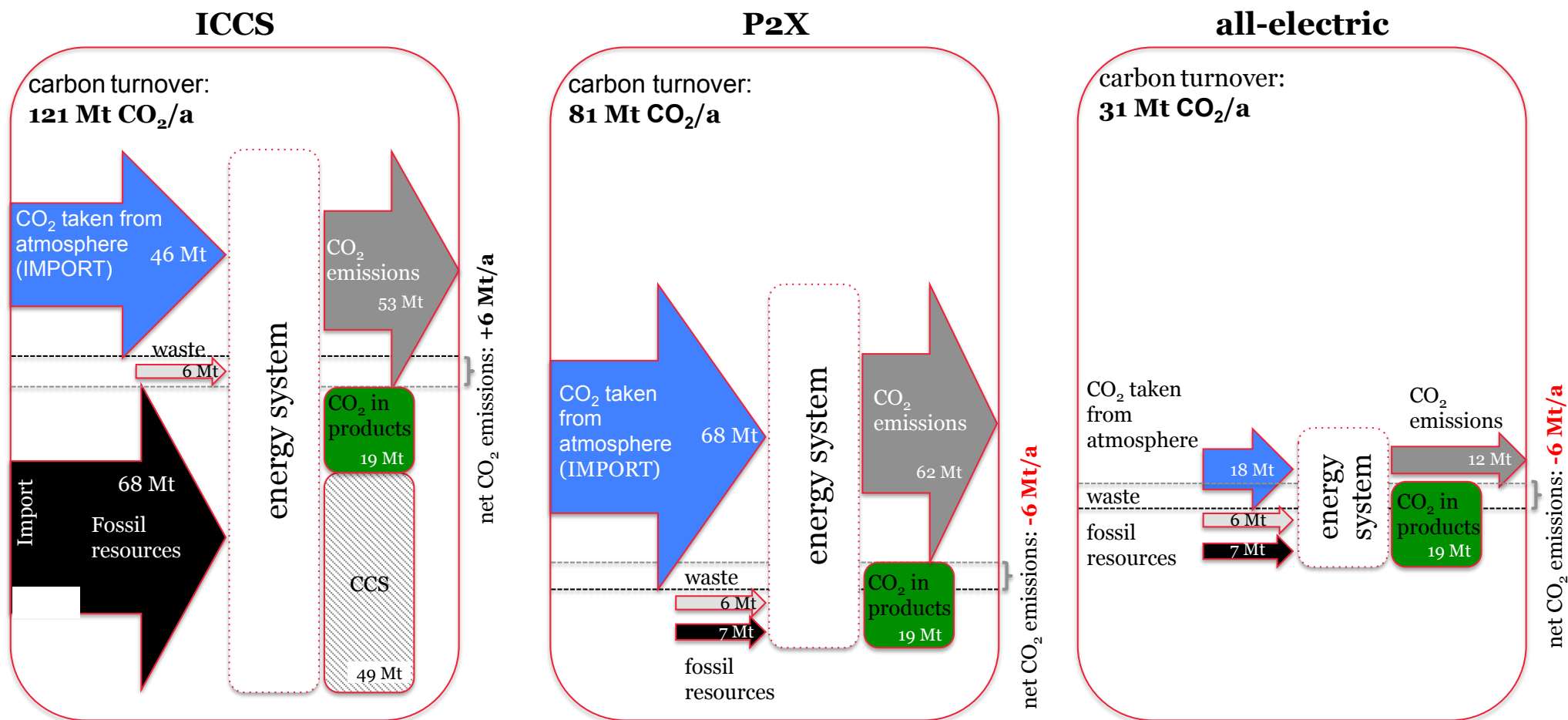
- infrastructure programmes, investment schemes
- Go for public acceptance for industry and the infrastructure transition.
- Cross-border approach: Joint approach for the triangle NRW/Flanders/South Holland

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Thank you
for your attention!

How is carbon neutrality achieved?

Carbon balances of the three scenarios



Source: own figure.