Role of Logistics in a Resilient Net Zero Europe

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Hamburg

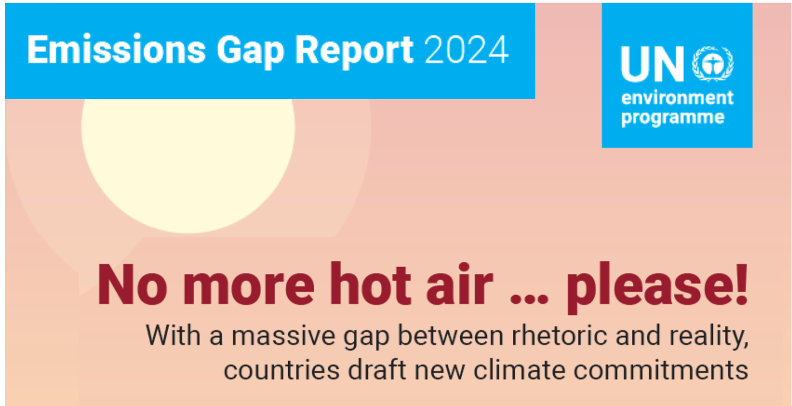
‘*Industry and logistics as pioneers of the green transformation in Central and Eastern Europe*’

East European Business Conference

KLU

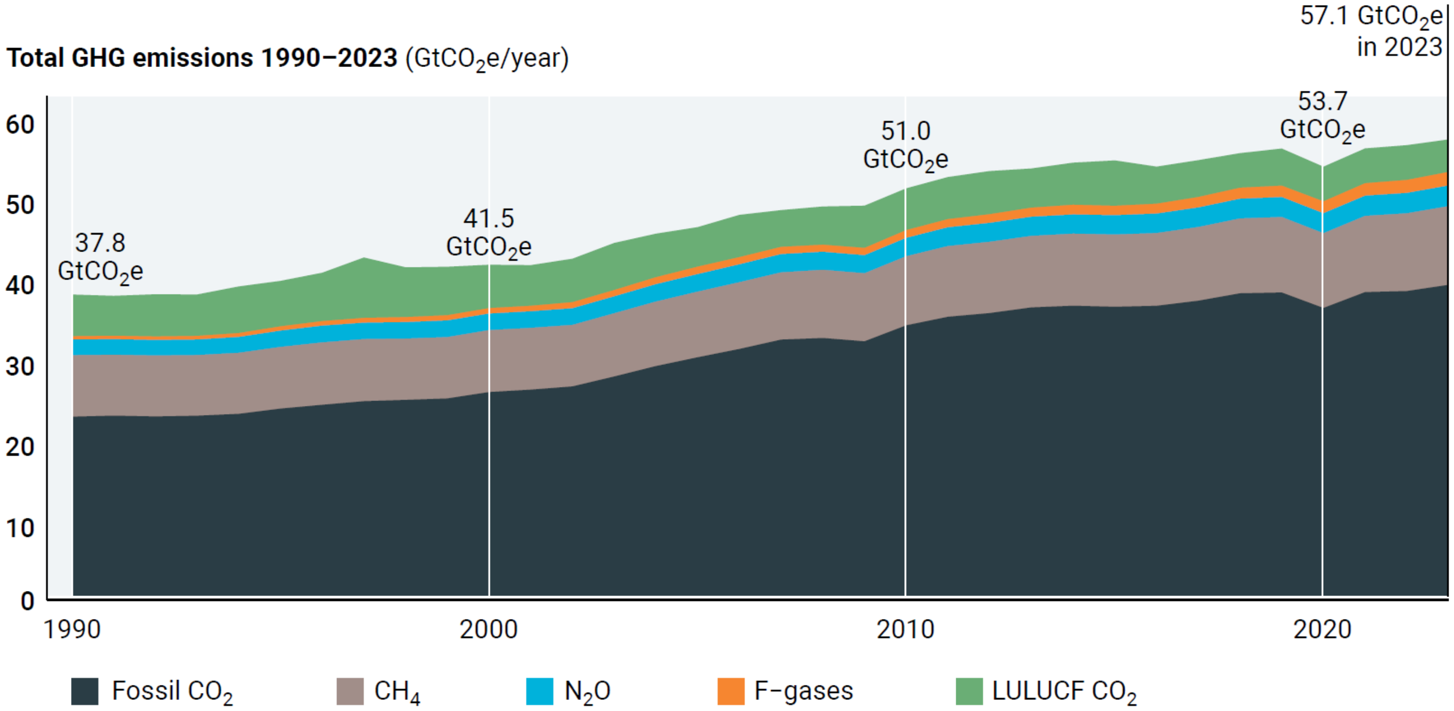
28 November 2024

Brief Update on the Climate Science



https://www.unep.org/resources/emissions-gap-report-2024

'We are on the brink of an irreversible climate disaster. This is a global emergency beyond any doubt. Much of the fabric of life on Earth is imperilled. We are stepping into a critical and unpredictable new phase of the climate crisis.' 2024 State of the Climate Report (Oct 2024)



GLOBAL CARBON BUDGET

2024 Report

Remaining budget for a 50% chance of staying within 1.5°C global temperature rise:

235 Gt of CO_2

At current rate of emissions will be exhausted **by 2031**

https://essd.copernicus.org/preprints/essd-2024-519/

Pursuit of **Net Zero**

NET ZERO TRACKER

Proportion of Global GDP covered by Net Zero pledges: 2019 **16%** → 2024 **93%**

Net Zero: reduce emissions as much as possible by **mitigation** measures with any surplus balanced by the removal of CO_2 from the atmosphere by carbon **sequestration** processes

European Scientific Advisory Board on Climate Change

EU **Residual Gross Emissions** in 2050: between **390 and 1165 million tonnes of CO_{2e}** will need to be removed **annually** from the atmosphere. **(Germany emitted 674 Mt of CO_{2e} in 2023)**

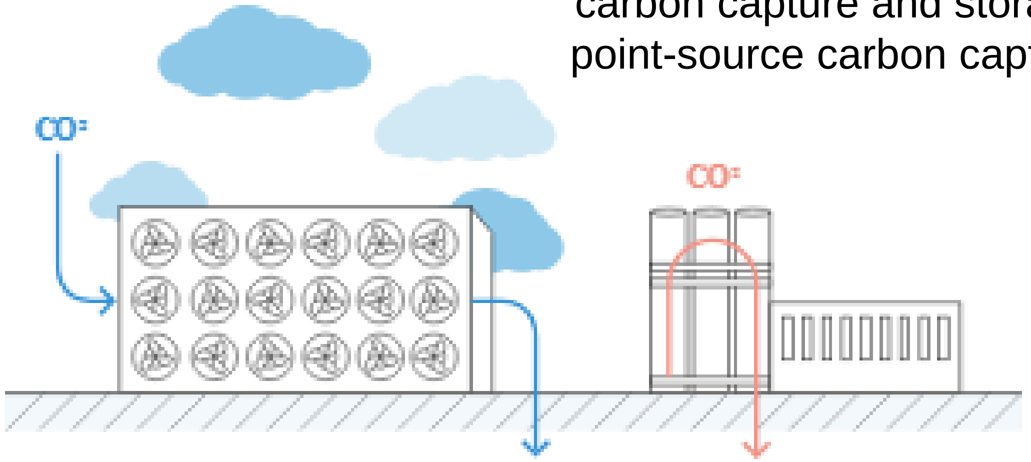
concentration of CO_2 in the atmosphere

422 parts per million

0.04% of the air

carbon sequestration
carbon dioxide removal
negative emissions

carbon capture and storage
point-source carbon capture



typical concentrations of CO_2 in exhaust / chimney gases

gas boilers:	4%
coal-fired power plants:	10-12%
chemical plants:	10%
cement kilns / blast furnaces:	10-40%
liquid natural gas plants:	90-100%

nature reviews earth & environment
Controversies of carbon dioxide removal

Institute for Energy Economics and Financial Analysis

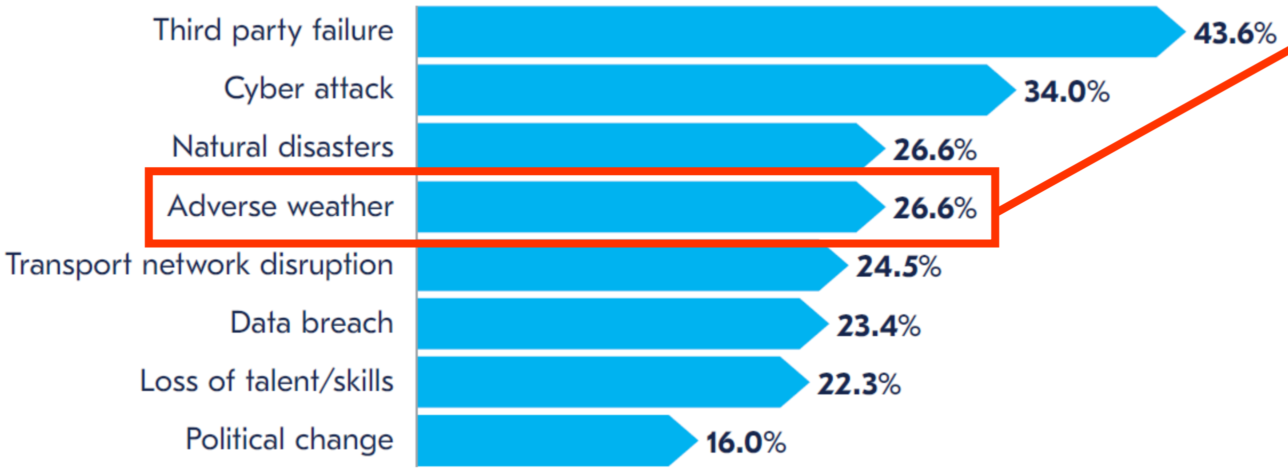
Carbon capture: a decarbonisation pipe dream

Role of Climate in Supply Chain Risk and **Resilience**

Supply chain resilience report 2024

Global https://www.weforum.org/publications/global-risks-report-2024/ Risks report 2024

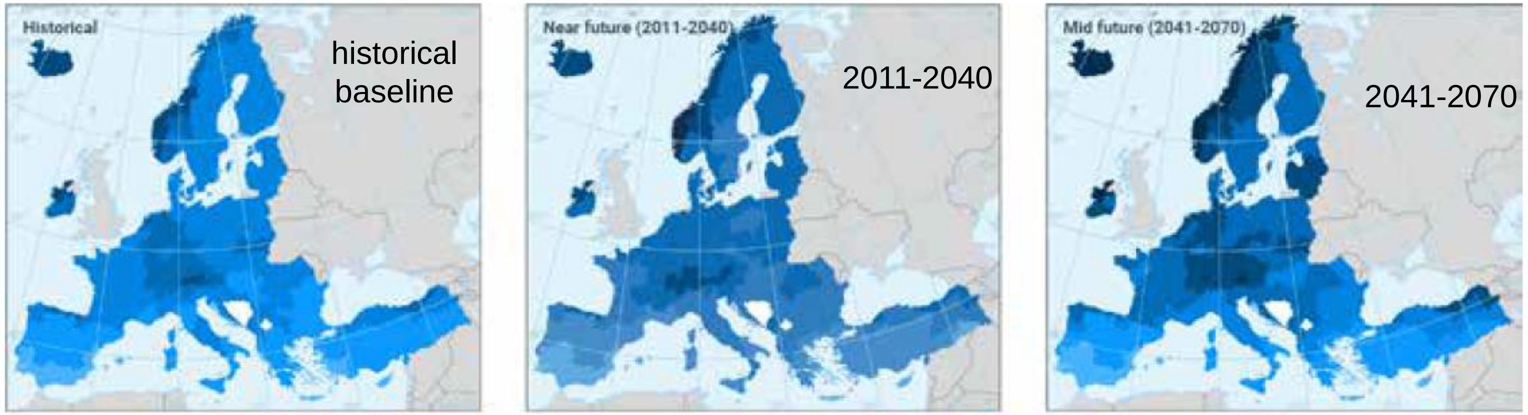
Causes of supply chain disruptions in the past year



Long term (10 years) Global risks ranked by severity

1st	Extreme weather events
2nd	Critical change to Earth systems
3rd	Biodiversity loss and ecosystem collapse
4th	Natural resource shortages
5th	Misinformation and disinformation
6th	Adverse outcomes of AI technologies
7th	Involuntary migration
8th	Cyber insecurity

extreme precipitation: *days per annum*

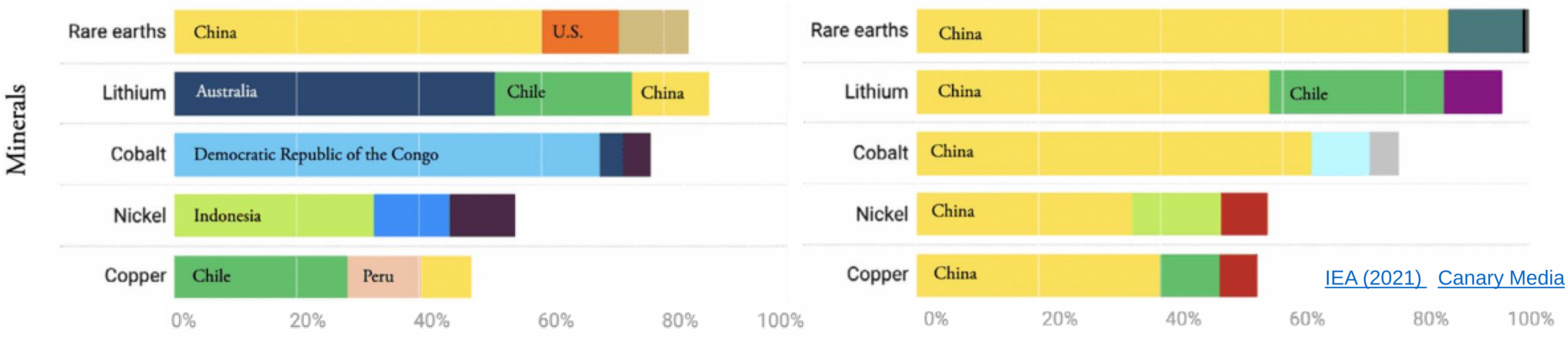


European Environment Agency 2024

Materials for the Transition to Renewable Energy: *resilience of supply chains to **geopolitical risk**?*

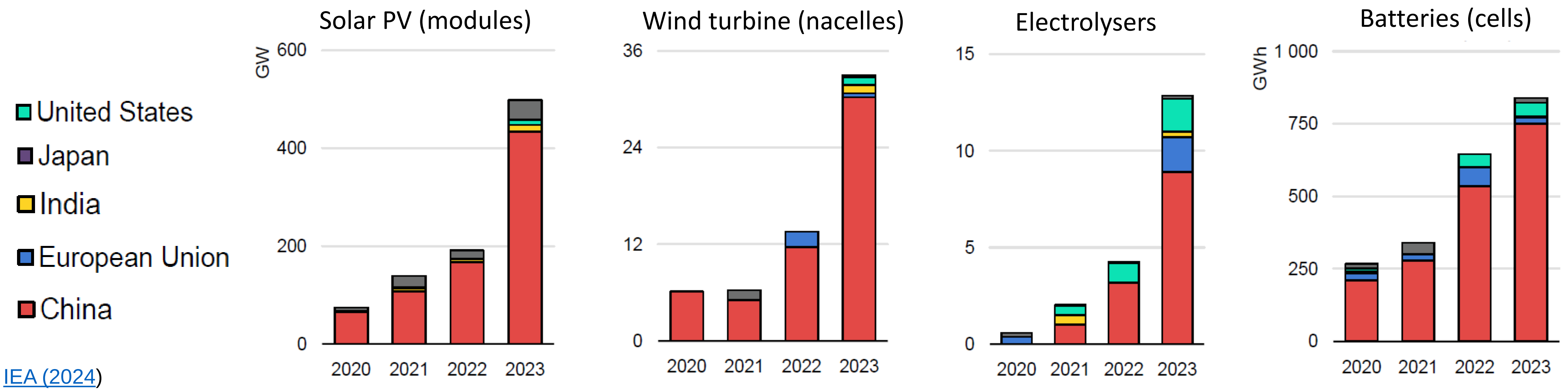
global market shares

extraction | processing



IEA (2021) Canary Media

additions to manufacturing capacity for low carbon technologies



IEA (2024)

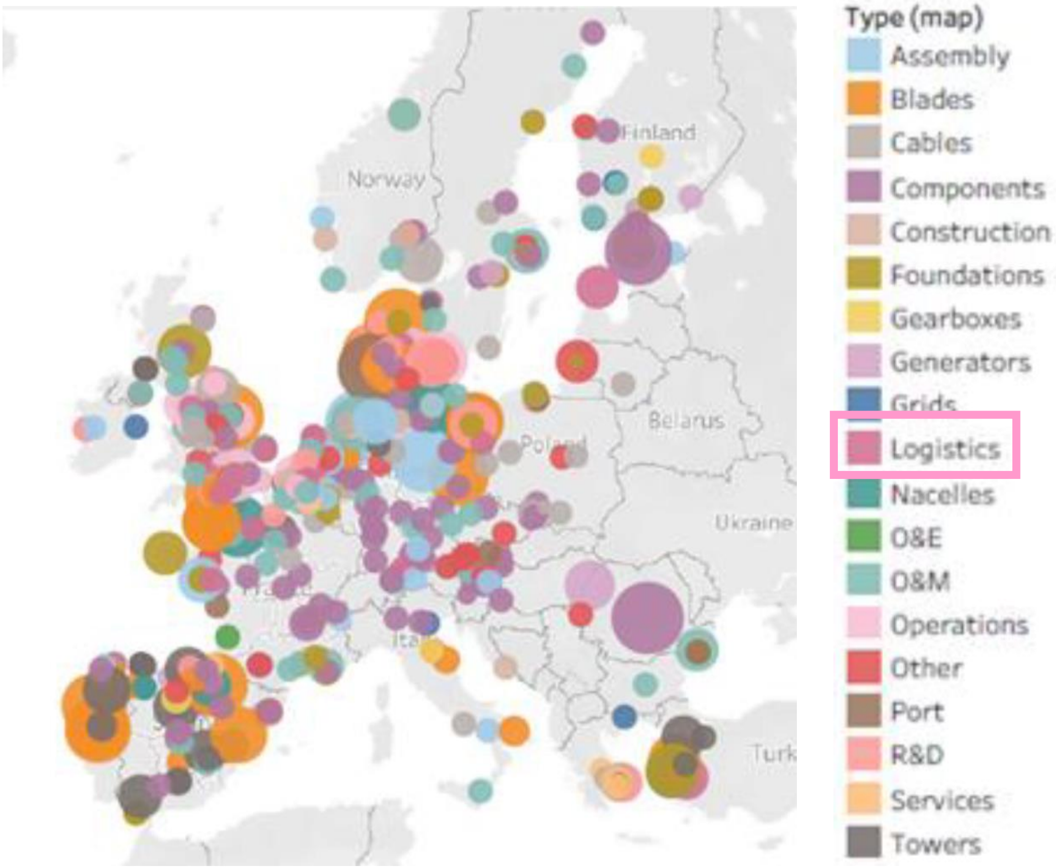
EU Initiatives to Diversify and Internalize the Sourcing of Green Materials and Technologies

EUROPEAN COMMISSION

A Green Deal Industrial Plan for the Net-Zero Age

Critical Raw Materials Club *to deliver on a secure, sustainable and affordable global supply of raw materials essential to our green and digital transition with a competitive and diversified industrial base.*

diversity and extent of European wind turbine manufacture



Logistical implications of EU efforts to mitigate risks
In the supply of low carbon technologies

reconfiguring of EU external trading links for 'clean technology'

reducing total dependence on global sourcing of green tech & materials

increasing related logistical activity and emissions <u>within the EU</u>

Multiple Roles of Logistics in the Climate Crisis

GHG emissions

Cause

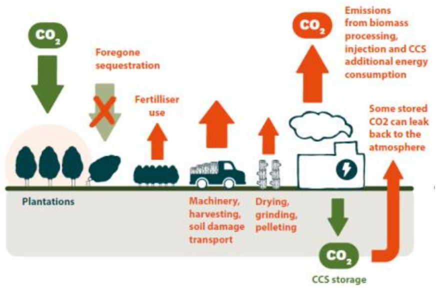
Decarboniser

Last resort

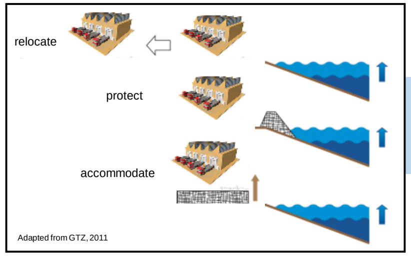
CLIMATE CRISIS

Victim

Remover



Rescuer



Adaptor

Facilitator

Logistics and climate: an assessment of logistics' multiple roles in the climate crisis

Alan C. McKinnon

CarbonBrief
CLEAR ON CLIMATE

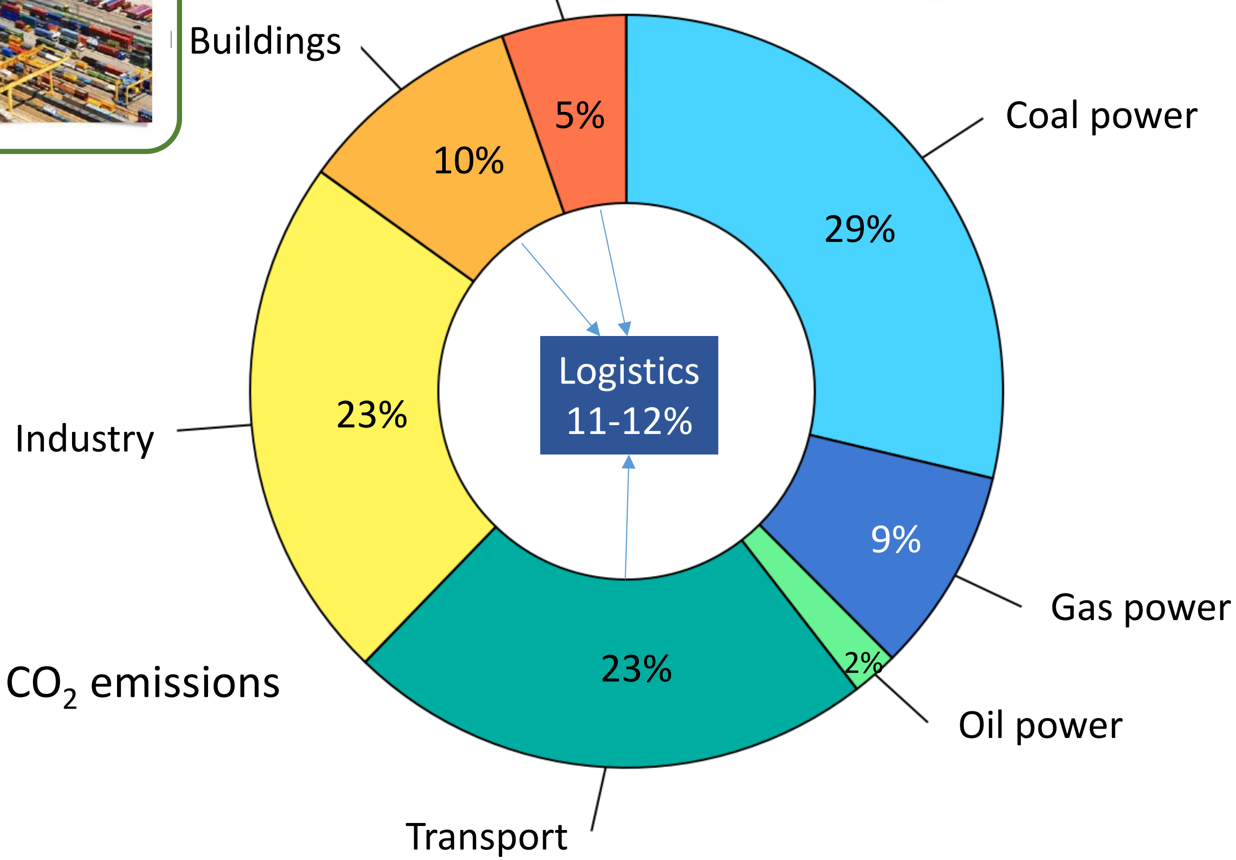
Guest post: The forgotten role of logistics in achieving net-zero

Logistics as a CAUSE

Logistics' Global Carbon Score-card

warehousing and terminals- 1-2%

administration / IT ?



Energy-related CO_2 emissions

freight transport 9.6%

https://www.iea.org/data-and-statistics/charts/global-energy-related-co2-emissions-by-sector

Logistics annual emissions:
4.2 Gtonnes of energy-related CO_2

If it were a country.....

Million tonnes CO_2 (2020)

1	China	11680
2	United States	4535
3	Logistics	4200
4	India	2411
5	Russia	1674
6	Japan	1061
7	Iran	690
8	Germany	636
9	South Africa	621
10	Saudia Arabia	589

Significant under-estimation

Exclude emissions from energy supply chains

and emissions of other GHGs (methane, nitrous oxide, refrigerant gases) and black carbon particles

No comparable statistics for logistics' share of EU GHG emissions

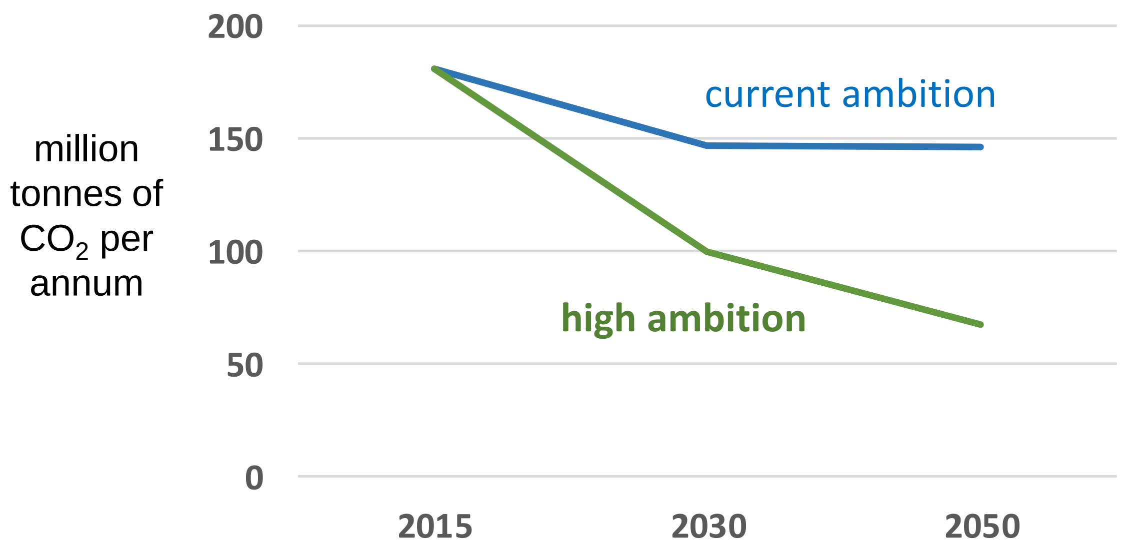
Logistics as a DECARBONISER

very difficult activity to decarbonise

- heavy dependence on fossil fuel
- high forecast growth of freight movement
- long life of freight assets *(typical replacement rate in years)*

van	truck	locomotive	ship	plane
5-7	10-15	25-30	30	30

trends in CO_2 emissions from EU freight transport: *2 scenarios*



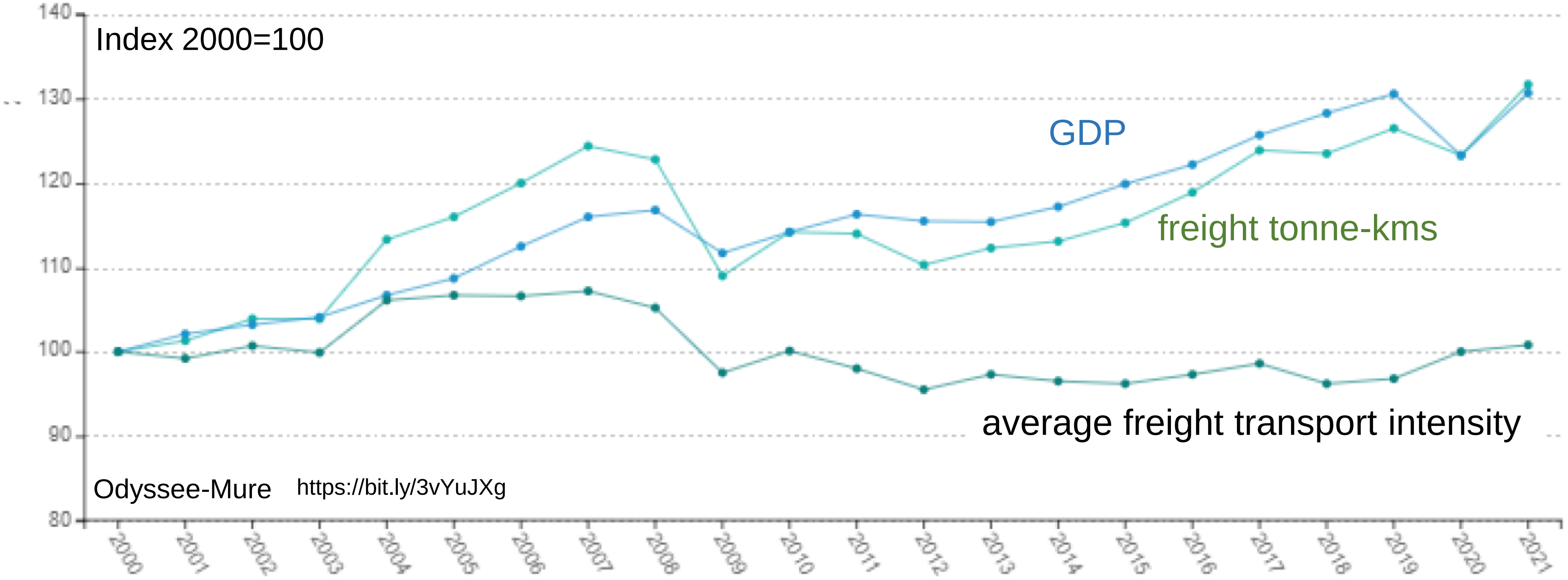
International Transport Forum 2021

5 Freight Transport Decarbonisation Levers

1. Reduce the total amount of freight movement
2. Shift freight to lower carbon transport modes
3. Optimize utilization of freight transport capacity
4. Improve energy efficiency of freight movement
5. Transition freight transport to low carbon energy

1. Reduce the total amount of freight movement / constrain the rate of freight traffic growth

EU reference scenario: ***27% increase** in total freight tonne-kms between 2020 and 2030* https://bit.ly/490wnp2



very close correlation in EU between economic and freight traffic growth

regional cohesion policies and reshoring of production to the EU likely to increase average freight transport intensity

circular economy

dematerialisation

fossil fuel phase-out

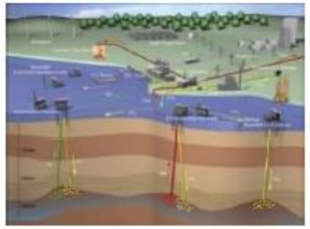
3D printing

Examples of future drivers of road freight demand pushing in opposite directions

renewable energy infrastructure

carbon sequestration

climate change adaptation

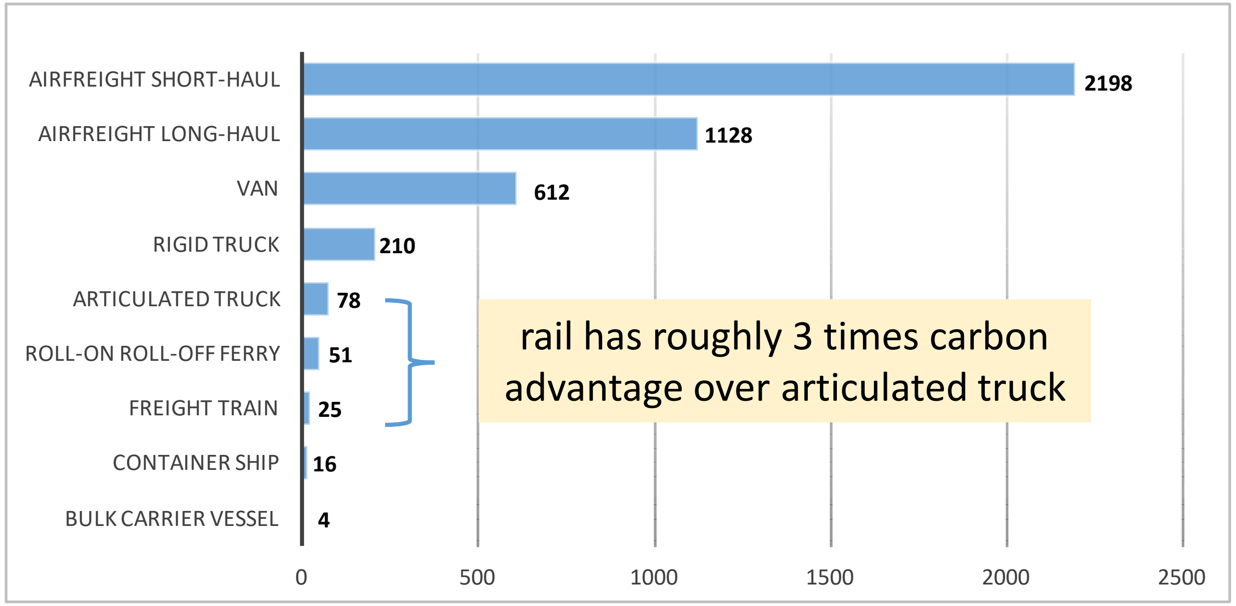


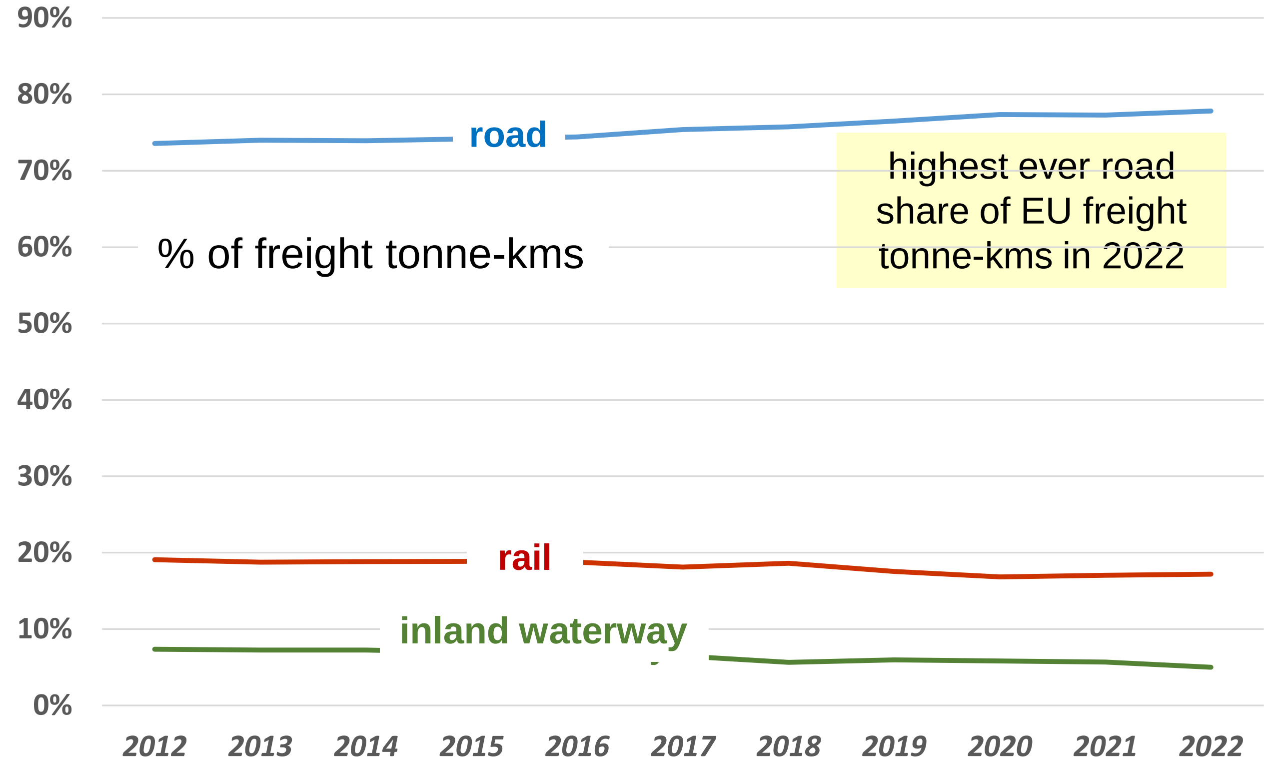
2. Shift freight to lower carbon transport modes

Eurostat (2024) https://bit.ly/4aYxZRk

wide variation in the carbon intensity of transport modes

average carbon intensity of freight transport modes: *gCO_2 / tonne-km*





EU reference scenario: *71% increase in rail freight tonne-kms between 2020 and 2040 – still only 19% modal share*

https://bit.ly/490wnp2

- history of over-ambitious freight modal shift targets not achieved
- long term ‘*logistical lock-in*’ to trucking is very difficult to reverse
- decarbonisation of EU economy depriving rail of fossil fuel traffic

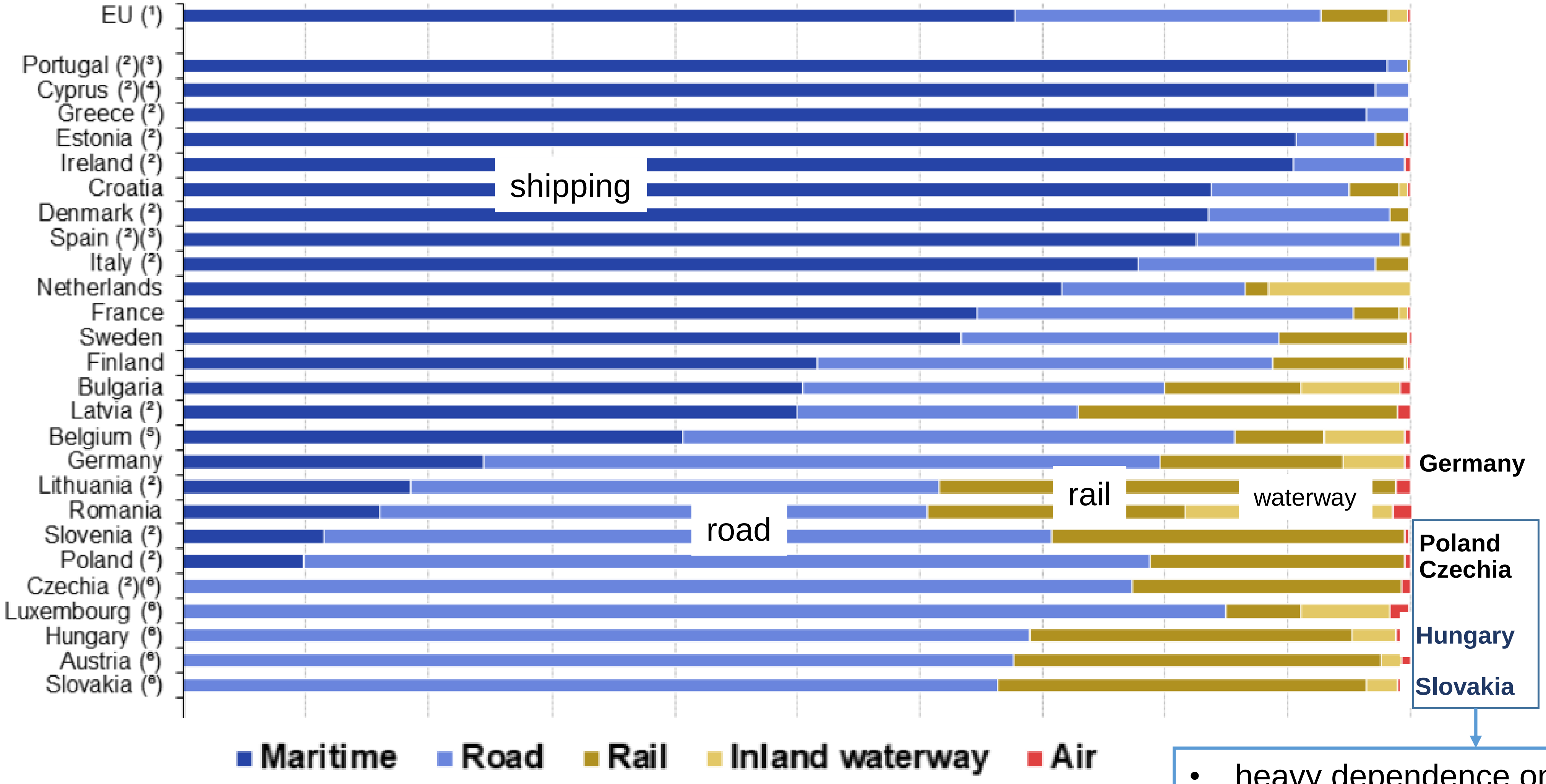
CURIA RATIONUM EUROPEAN COURT OF AUDITORS

August 2023
https://bit.ly/4b3yJ7Y

‘…unrealistic EU targets for 2030 and 2050 for the increased use of rail and inland waterways for the transport of freight. These targets were not based on robust simulations of how much modal shift could be achieved.‘

2. Shift freight to lower carbon transport modes

Relative Use of Different Freight Transport Modes across the EU *(% of total tonne-kms)*



- heavy dependence on road carriers
- rail is the main alternative mode
- minimal use of waterborne transport

Eurostat (2024) https://bit.ly/4aYxZRk

3. Optimise the utilisation of freight transport capacity

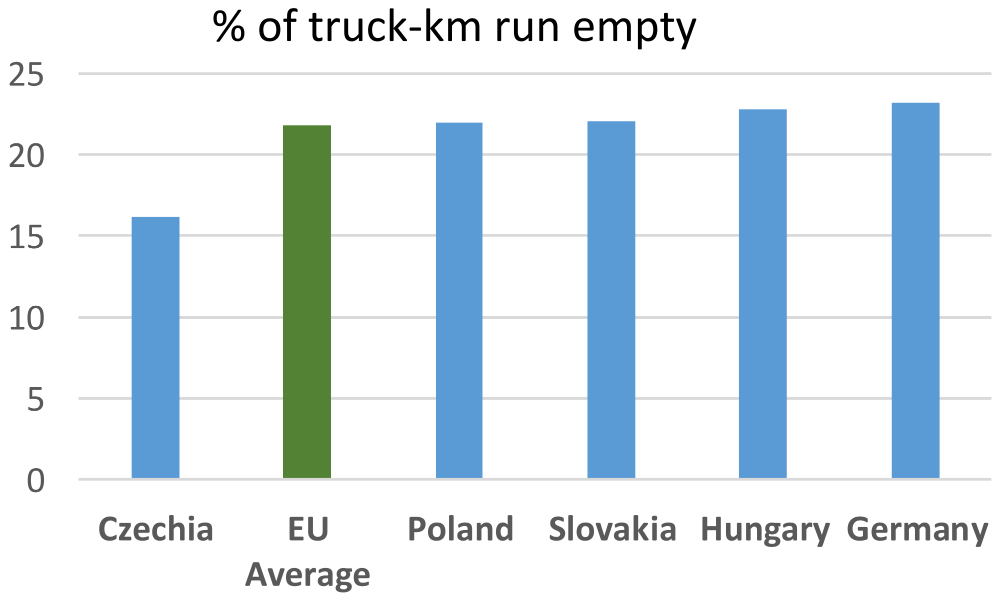
large potential emission savings | both economic and environmental benefit | short-medium term implementation

Chronic lack of data on the utilisation of freight transport capacity

https://bit.ly/4fw9QDQ

empty running of trucks

under-loading



2010 24% 2022 22%

ways of raising vehicle load factors

Logistical collaboration
– *sharing assets*

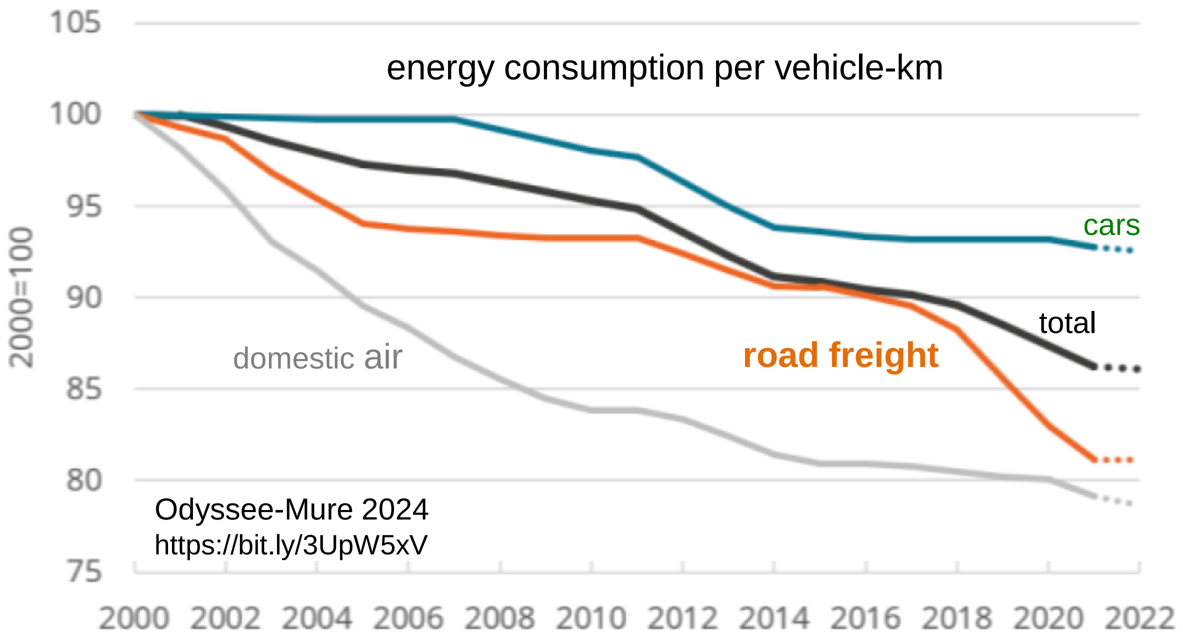
Digitalisation of freight markets and operations

High-capacity transport
if infrastructure is adequate

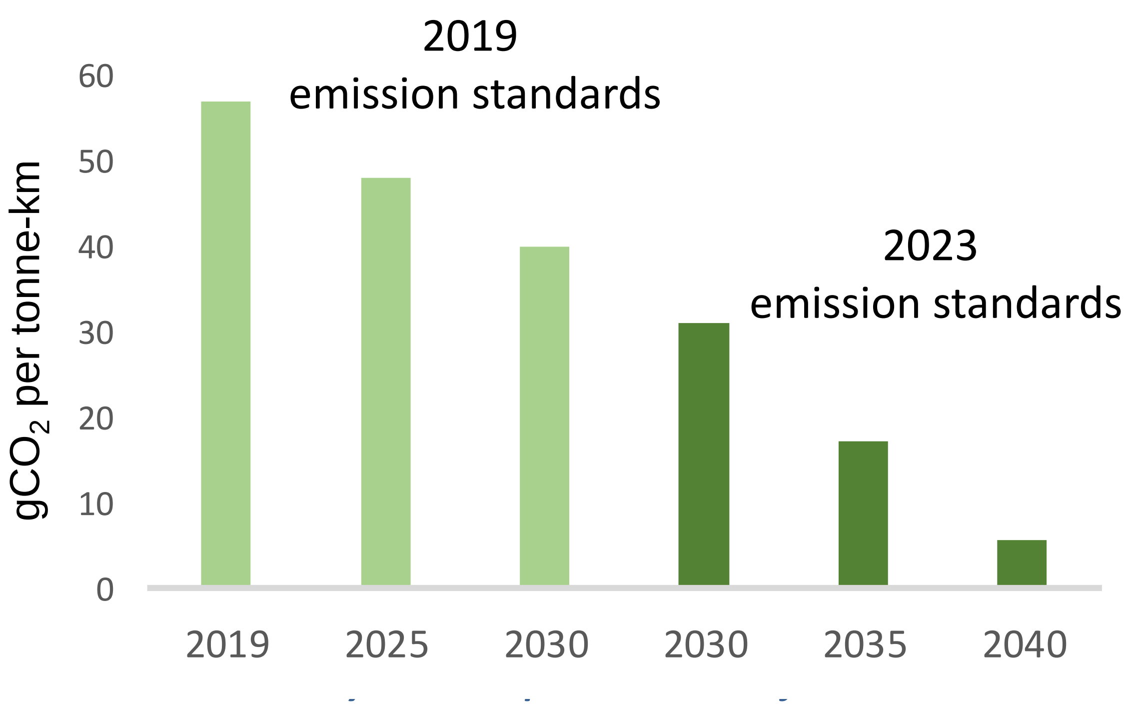
Relaxation of JIT pressures?

4. Improve the energy efficiency of freight transport

energy consumption per vehicle-km



EU fuel / CO_2 efficiency standards for new trucks



At average EU truck replacement rate of 5-7% per annum 15-18 years to replace entire truck fleet

average age of trucks much higher in some Eastern Europe countries, e.g. Slovakia, Czechia and Romania

short-to-medium term measures to improve the energy efficiency of existing fleets

5. Transition freight transport to low carbon energy






short haul road	long haul road	rail	shipping	airfreight
battery	**battery**	**catenary**	**e-methanol**	biofuel
‘pedal-power’	e-highway	**battery**	**green ammonia**	**e-kerosene**
	biogas	hydrogen (?)	biofuel	hydrogen (?)
	HVO		**battery / shore power**	battery
	hydrogen (?)		wind	

heavily dependent on direct or indirect **electrification** of the freight transport system and decarbonisation of the electricity supply

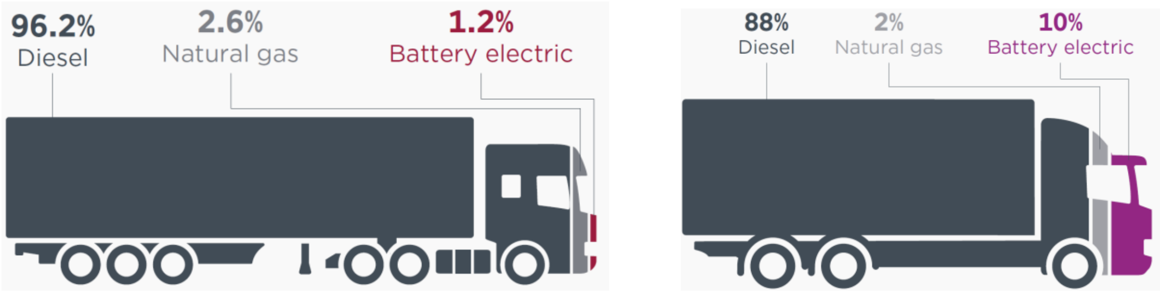
need captured CO_2 as a feedstock

slow transition

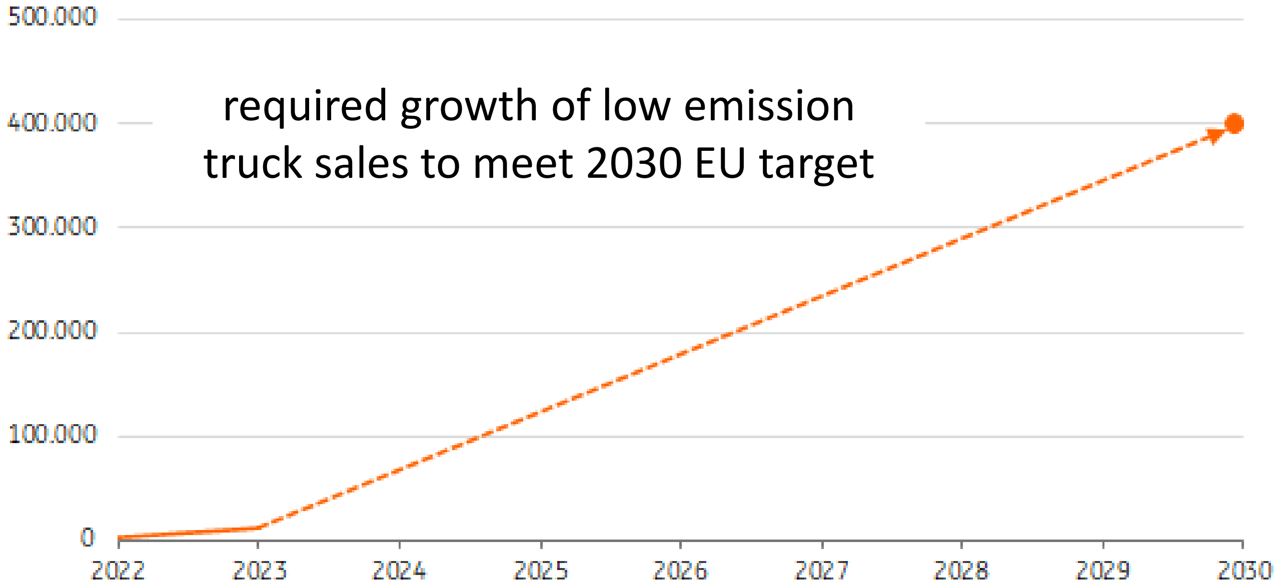
coordinating the development of **transport and energy infrastructures** with the **manufacture of new low carbon vehicles** and **operators’ fleet replacement cycles.**

5. Transition freight transport to low carbon energy

European truck sales (Q2 2024) by energy type



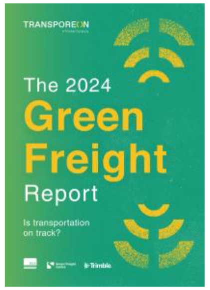
ICCT (2024) https://bit.ly/3AP7th1

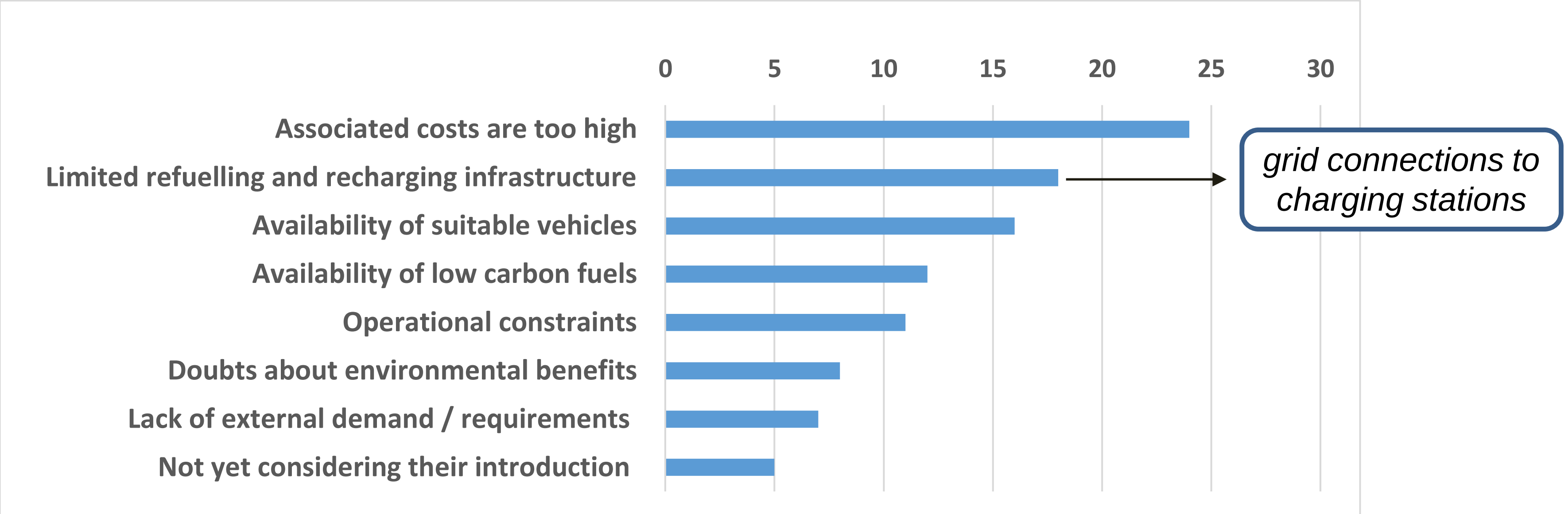


https://think.ing.com/articles/european-truck-market-slows-while-electric-journey-accelerates/

relative importance of the main barriers to implementing low/zero CO_2 emission fuels and vehicles

% of consolidated responses





Logistics as a VICTIM

Few Activities are as Exposed to Climate Risk as Logistics

geographically extensive

closely inter-connected

time-sensitive

Key weather variables

Temperature

Precipitation

Wind

Logistics assets

vehicles

road infrastructure

refuelling / recharging stations

warehousing

terminals

Geophysical impacts

Flooding

Landslides

Subsidence

Pavement heat damage

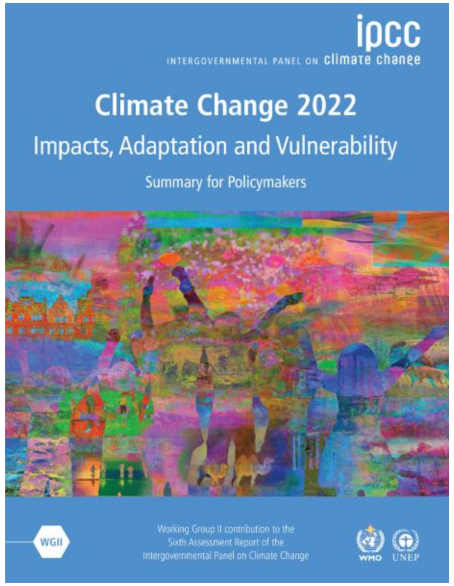
Wildfires

Ice / snow-related

energy and communication infrastructure

Logistics as an ADAPTOR

3068 pages

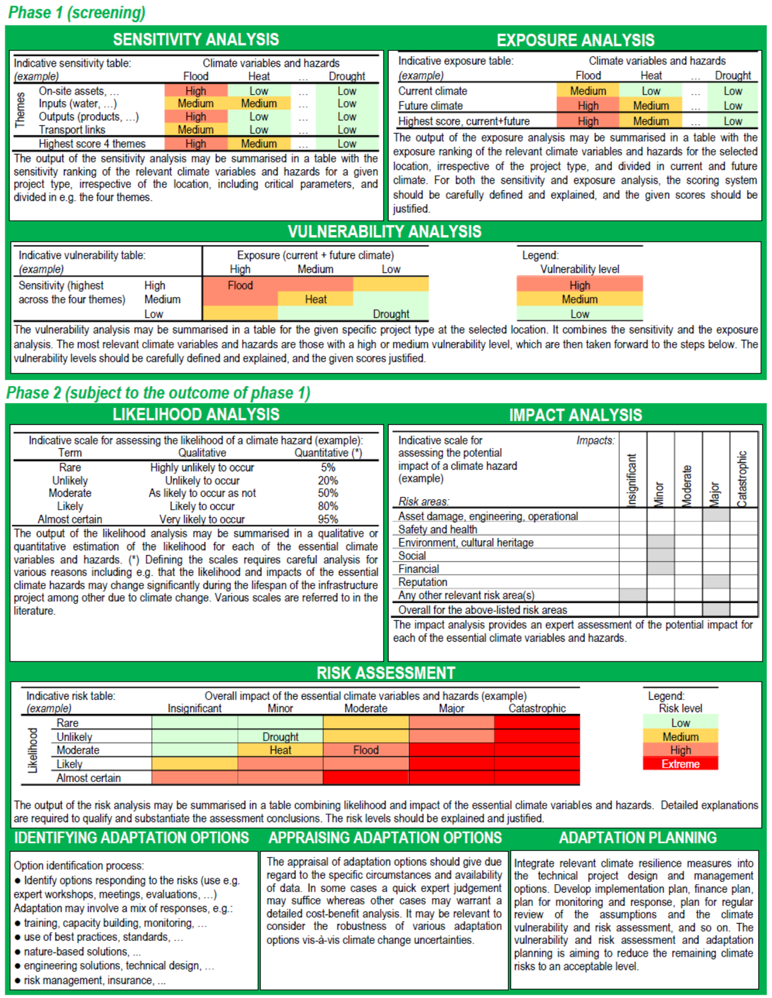


3 brief references to vulnerability and adaptation of logistics systems

Little research on the climate adaptation of **road freight operations and logistical systems** as a whole to climate change

Logistics and supply chains are ‘*adaptation blind spots*’ in the private sector. Goldstein et al 2019

EU guidance on climate proofing infrastructure



Phase 1 (screening)

SENSITIVITY ANALYSIS

Indicative sensitivity table: *(example)*	Flood	Heat	...	Drought
Themes: On-site assets, ...	High	Low	...	Low
Inputs (water, ...)	Medium	Medium	...	Low
Outputs (products, ...)	High	Low	...	Low
Transport links	Medium	Low	...	Low
Highest score 4 themes	High	Medium	...	Low

(Climate variables and hazards)

The output of the sensitivity analysis may be summarised in a table with the sensitivity ranking of the relevant climate variables and hazards for a given project type, irrespective of the location, including critical parameters, and divided in e.g. the four themes.

EXPOSURE ANALYSIS

Indicative exposure table: *(example)*	Flood	Heat	...	Drought
Current climate	Medium	Low	...	Low
Future climate	High	Medium	...	Low
Highest score, current+future	High	Medium	...	Low

(Climate variables and hazards)

The output of the exposure analysis may be summarised in a table with the exposure ranking of the relevant climate variables and hazards for the selected location, irrespective of the project type, and divided in current and future climate. For both the sensitivity and exposure analysis, the scoring system should be carefully defined and explained, and the given scores should be justified.

VULNERABILITY ANALYSIS

Indicative vulnerability table: *(example)*		Exposure (current + future climate): High	Medium	Low
Sensitivity (highest across the four themes)	High	Flood		
	Medium		Heat	
	Low			Drought

Legend: Vulnerability level: High, Medium, Low

The vulnerability analysis may be summarised in a table for the given specific project type at the selected location. It combines the sensitivity and the exposure analysis. The most relevant climate variables and hazards are those with a high or medium vulnerability level, which are then taken forward to the steps below. The vulnerability levels should be carefully defined and explained, and the given scores justified.

Phase 2 (subject to the outcome of phase 1)

LIKELIHOOD ANALYSIS

Indicative scale for assessing the likelihood of a climate hazard (example):

Term	Qualitative	Quantitative (*)
Rare	Highly unlikely to occur	5%
Unlikely	Unlikely to occur	20%
Moderate	As likely to occur as not	50%
Likely	Likely to occur	80%
Almost certain	Very likely to occur	95%

The output of the likelihood analysis may be summarised in a qualitative or quantitative estimation of the likelihood for each of the essential climate variables and hazards. (*) Defining the scales requires careful analysis for various reasons including e.g. that the likelihood and impacts of the essential climate hazards may change significantly during the lifespan of the infrastructure project among other due to climate change. Various scales are referred to in the literature.

IMPACT ANALYSIS

Indicative scale for assessing the potential impact of a climate hazard (example) — Risk areas:	Insignificant	Minor	Moderate	Major	Catastrophic
Asset damage, engineering, operational					
Safety and health					
Environment, cultural heritage					
Social					
Financial					
Reputation					
Any other relevant risk area(s)					
Overall for the above-listed risk areas					

The impact analysis provides an expert assessment of the potential impact for each of the essential climate variables and hazards.

RISK ASSESSMENT

Indicative risk table: *(example)* Likelihood	Insignificant	Minor	Moderate	Major	Catastrophic
Rare					
Unlikely		Drought			
Moderate		Heat	Flood		
Likely					
Almost certain					

(Overall impact of the essential climate variables and hazards (example))

Legend: Risk level: Low, Medium, High, Extreme

The output of the risk analysis may be summarised in a table combining likelihood and impact of the essential climate variables and hazards. Detailed explanations are required to qualify and substantiate the assessment conclusions. The risk levels should be explained and justified.

IDENTIFYING ADAPTATION OPTIONS

Option identification process:
- Identify options responding to the risks (use e.g. expert workshops, meetings, evaluations, ...)

Adaptation may involve a mix of responses, e.g.:
- training, capacity building, monitoring, ...
- use of best practices, standards, ...
- nature-based solutions, ...
- engineering solutions, technical design, ...
- risk management, insurance, ...

APPRAISING ADAPTATION OPTIONS

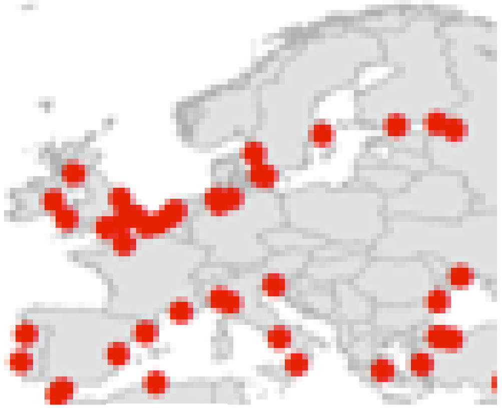
The appraisal of adaptation options should give due regard to the specific circumstances and availability of data. In some cases a quick expert judgement may suffice whereas other cases may warrant a detailed cost-benefit analysis. It may be relevant to consider the robustness of various adaptation options vis-à-vis climate change uncertainties.

ADAPTATION PLANNING

Integrate relevant climate resilience measures into the technical project design and management options. Develop implementation plan, finance plan, plan for monitoring and response, plan for regular review of the assumptions and the climate vulnerability and risk assessment, and so on. The vulnerability and risk assessment and adaptation planning is aiming to reduce the remaining climate risks to an acceptable level.

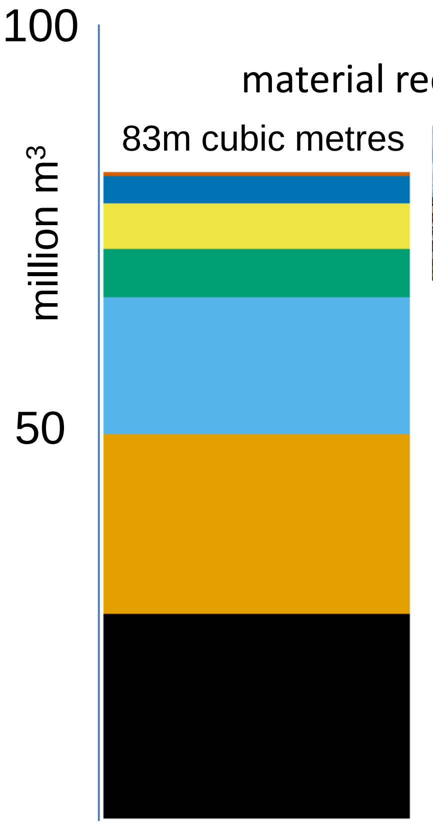
No EU estimates of the **quantity of materials required and the amount of freight movement** needed to source, process and distribute them.

climate protection for 36 European ports to 2 metre sea level rise



material requirements

83m cubic metres



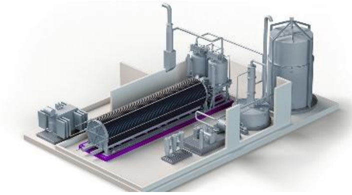
x1000

Becker and Chase (2016)

Logistics as a FACILITATOR

Critical to the Decarbonisation of other Activities: *e.g. energy generation*

Transitioning from Fossil to Renewable Energy ***creation of new renewable energy infrastructure***

renewal energy infrastructure more material-intensive in *tonnes per megawatt*

	steel	concrete
wind	460	870
coal	100	270
nuclear	40	195
natural gas	5	25

Source: Petersen (2006)

2030 forecast: 60m tonnes of 'structural materials' needed for wind turbines in EU

generation of renewable energy is more geographically dispersed than generation of 'fossil' energy

Germany 2022: 1055 wind turbines to produce as much electrical power as the country's largest coal-fired power station

complex global supply chains for renewable energy materials and equipment (*lithium, cobalt, batteries, solar panels etc.*)

much renewable power generation equipment 'out-of-guage' requiring specialist transport and handling

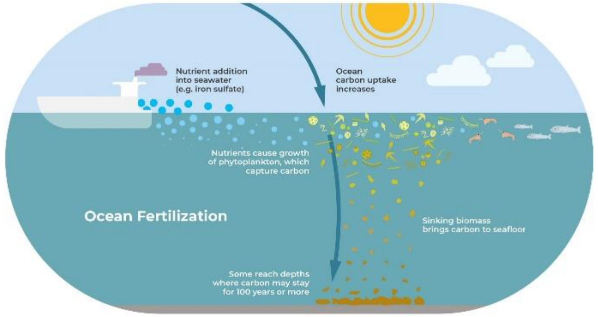
Logistics as a REMOVER

Main Methods of Carbon Dioxide Removal

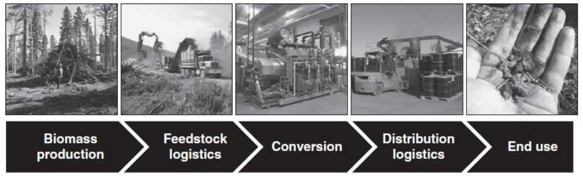
Nature-based methods

Afforestation

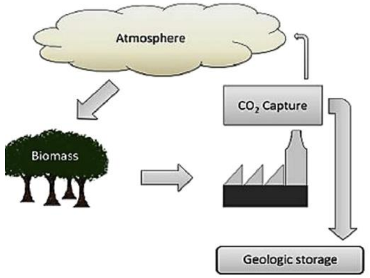
Ocean fertilisation



Hybrid nature-based and engineered sequestration



Biochar (charcoal-like substance produced by pyrolysis, rich in carbon, scattered on the land)



Bio-energy carbon capture and storage BECCS

Mechanical-chemical methods

'engineered CO_2 removal'

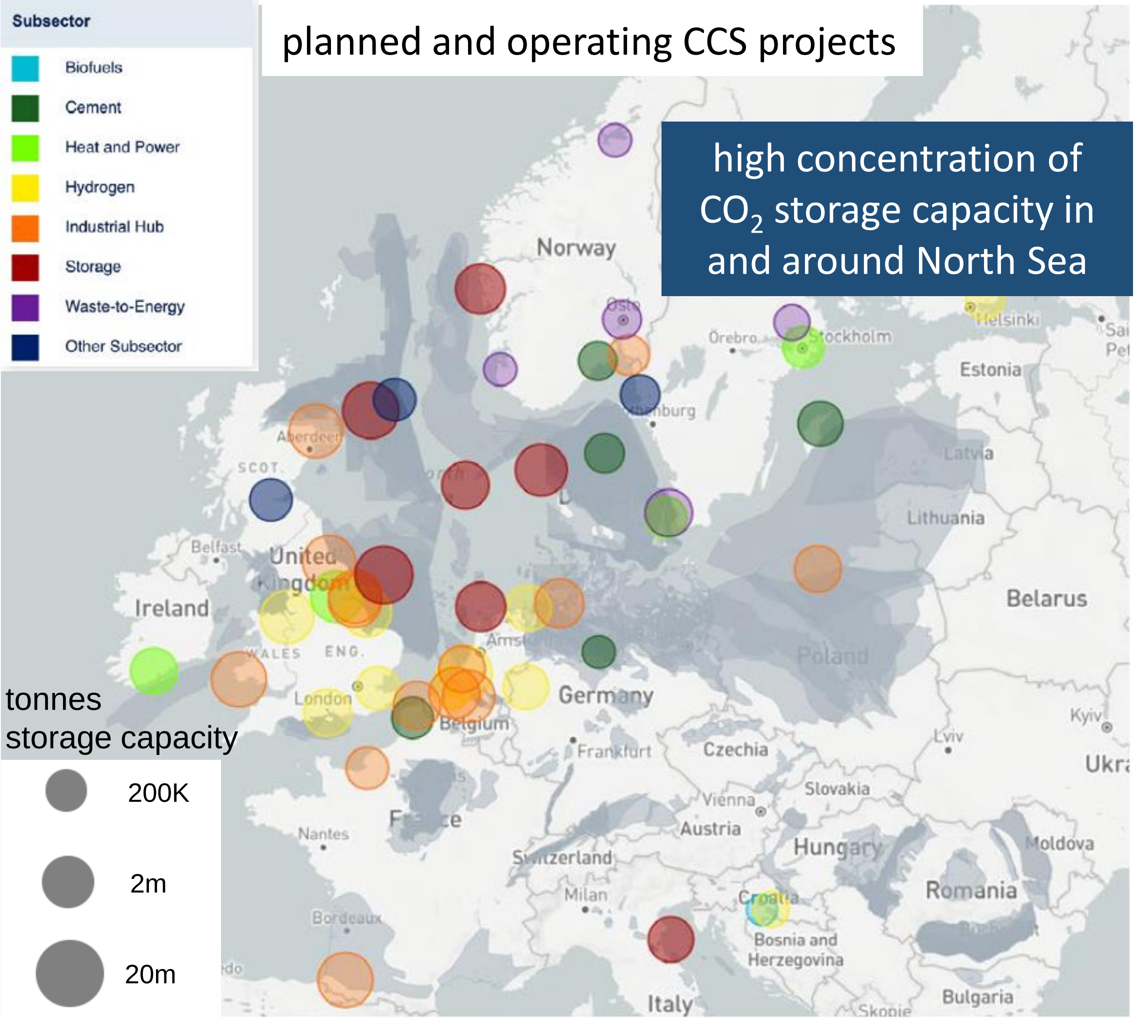
Enhanced rock weathering / Mineralisation

Direct air carbon capture and storage (DACCS)

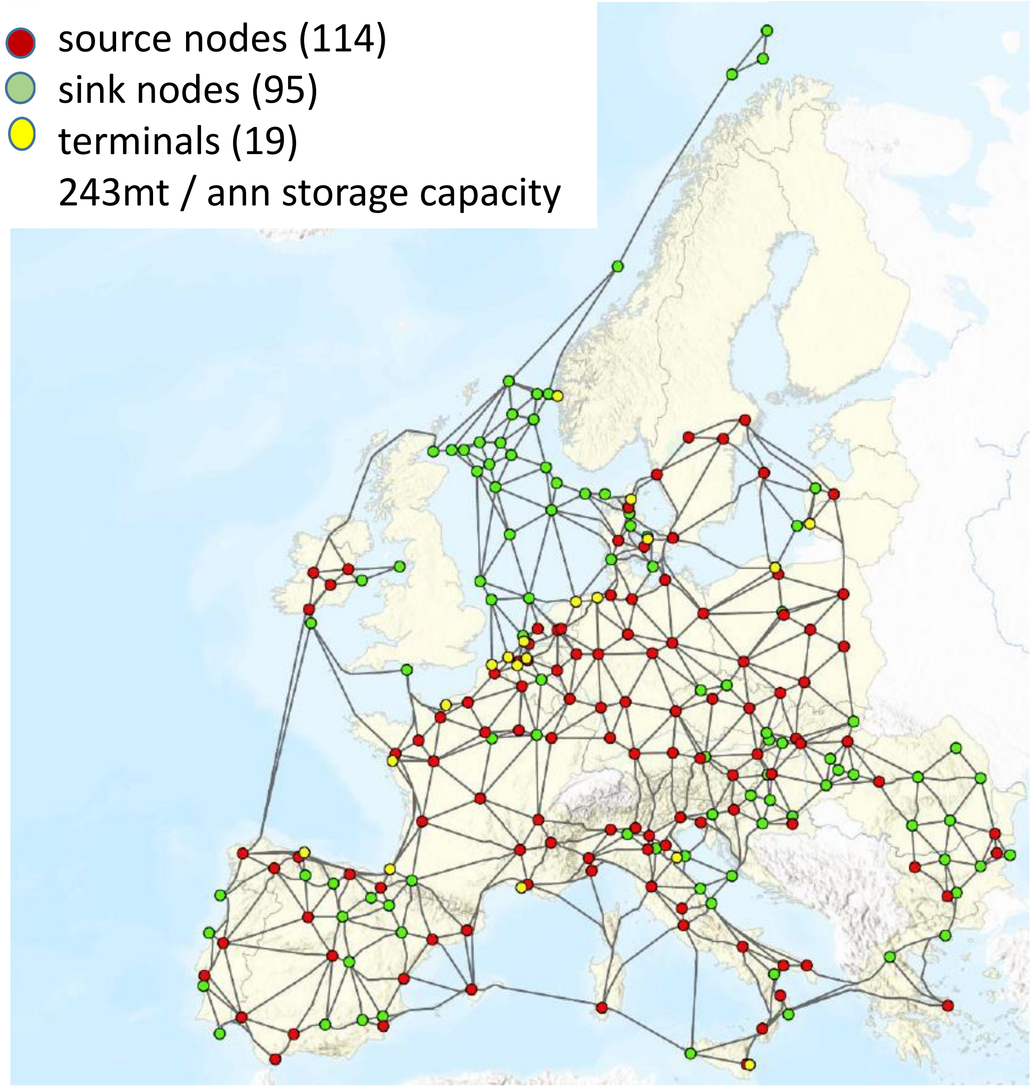
Logistical requirements vary widely, many as yet unquantified, but likely to be very freight transport-intensive

Movement of captured CO_2 likely to be mainly by pipeline and sea. Road will handle many of the other flows in CDR supply chains

Geography of European Carbon Capture **Transport** and Storage



Climate Target Plan 2040 scenario*: CO_2 transport network*



'To ensure Europe's emitting industries have equal access to the decarbonising potential of this infrastructure, it is vital to promote and facilitate the development of other suitable storage geology throughout the region, including onshore storage in **Central and Eastern Europe**, and offshore storage in the Mediterranean.'

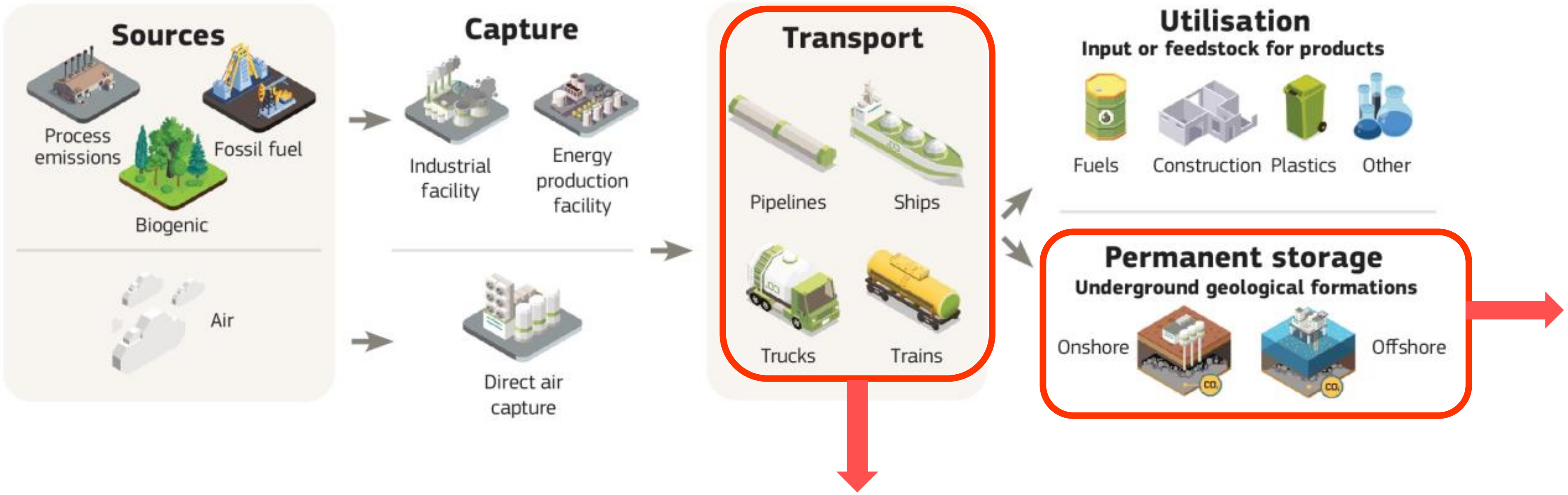
[Clean Air Task Force, 2022]

Transport network for captured CO_2

6700-7300km by 2030
15000-19000km by 2050

https://bit.ly/4eEXpos

Logistical Impact of Carbon Capture and Storage



EU Carbon Capture and Storage targets (million tonnes):

2030 **50**
2040 **280**
2050 **450**

Freight transport requirements of carbon dioxide removal

infrastructure

construction of CO_2 removal and storage facilities
electrical grid infrastructure for CDR facilities
pipeline networks for captured CO_2

equipment

supply chains for production of **CO_2 removal devices**
and vessels and vehicles to transport captured CO_2

10m '*mechanical trees*' per year

Prof Klaus Lackner

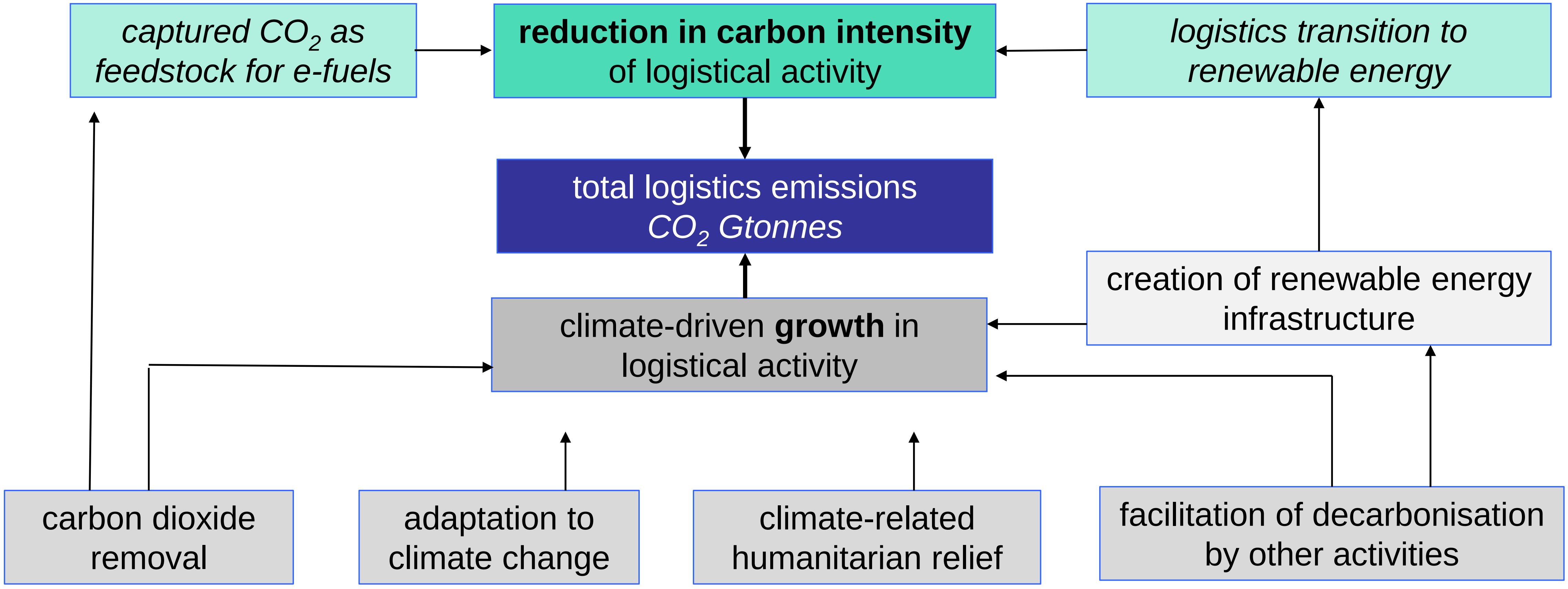
inputs

solvents / sorbents for the CO_2 removal process
biomass for BECCS
biochar, olivine, ocean fertilisation chemicals

outputs

captured CO_2 for storage or use
by-products of the sequestration process

Net Zero Logistics: *a Process Map and Four Recommendations*



Recommendations:

- **assess the logistical requirements** of the EU's Net Zero industrial plans
- **examine regional differences** in these requirements across the continent
- logistics businesses should explore **new commercial opportunities** arising in the Net Zero age
- award logistics sector **carbon credits for its critical roles** in the management of the climate crisis

Professor Alan McKinnon

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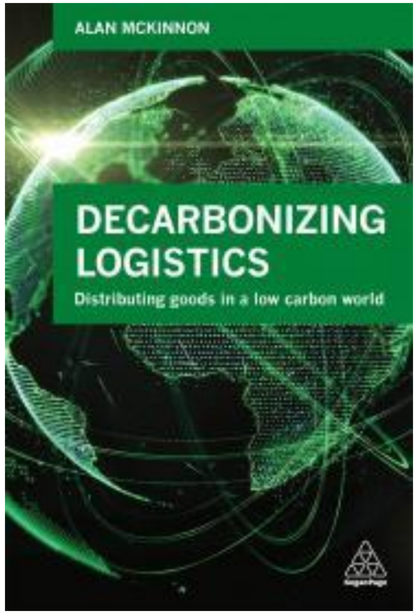
3 hour online video course

https://academy.smartfreightcentre.org/course/decarbonizing-logistics



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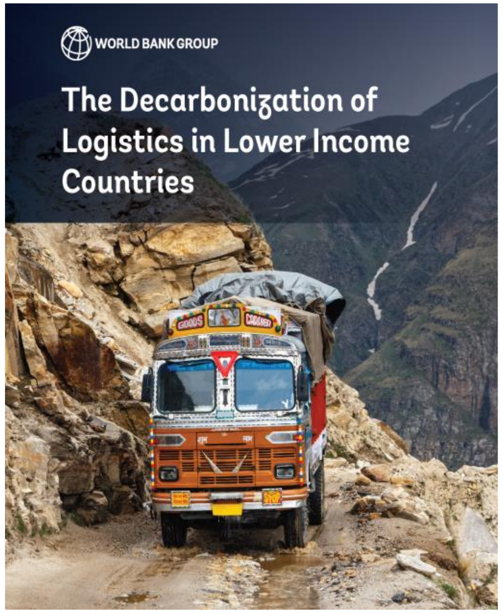

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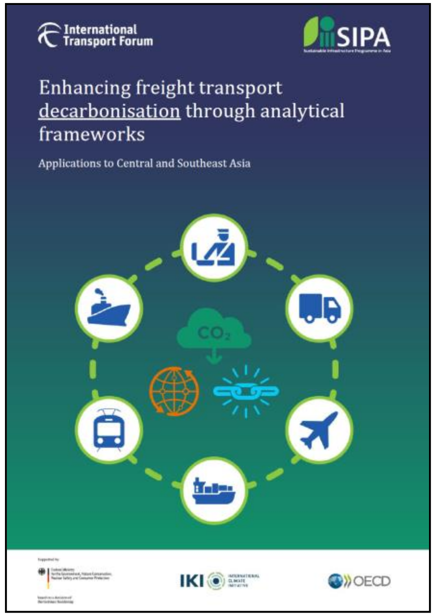

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