Decarbonization Targets and Measures to Achieve Them
Current State of Knowledge

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Kühne Logistics University

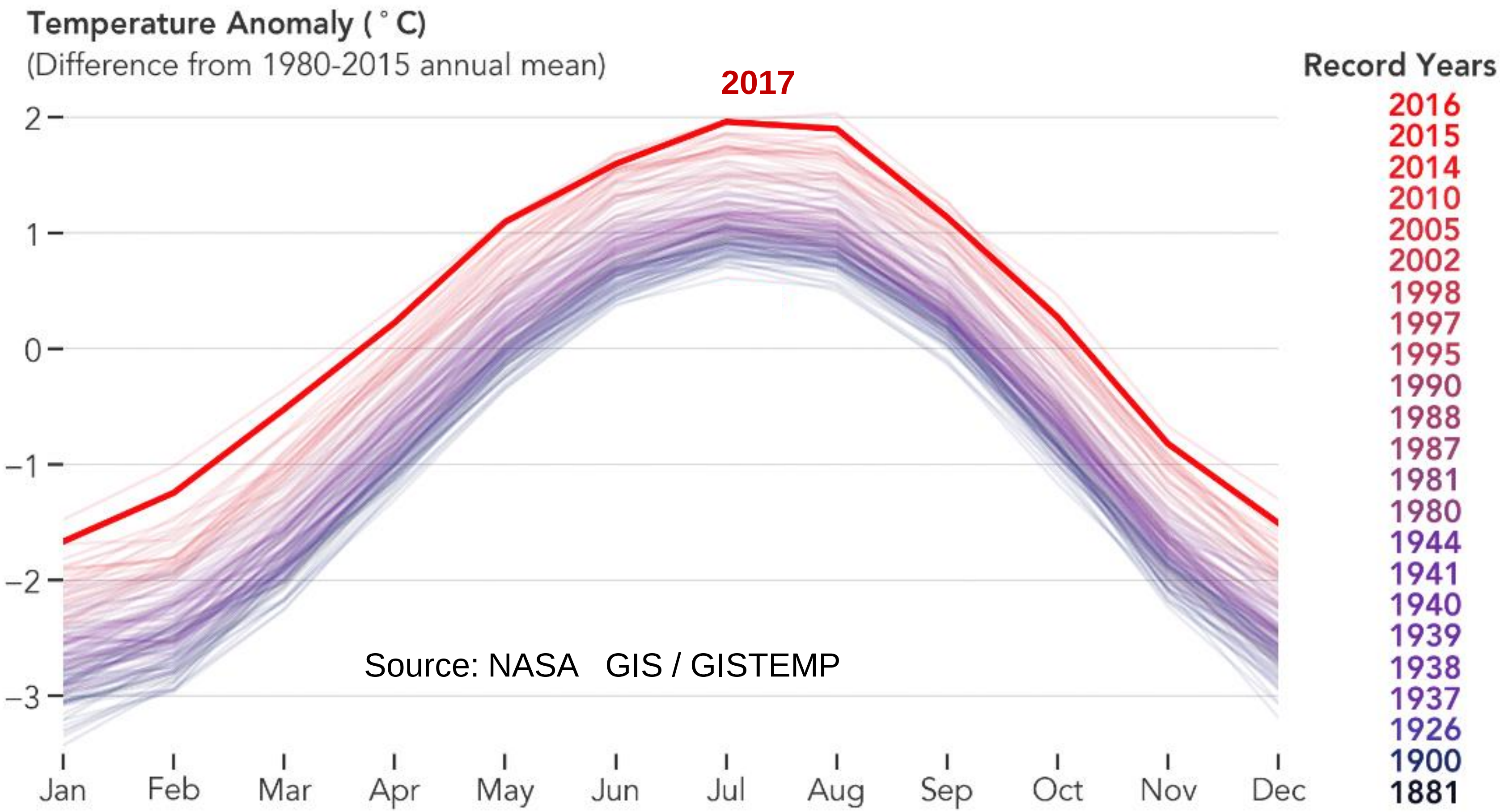
Towards 2050 Zero Emissions Logistics workshop 2

Logistics Emissions Reduction Paths

ALICE / LEARN Workshop

9th March 2018

Increase in Average Global Temperature 1881-2017

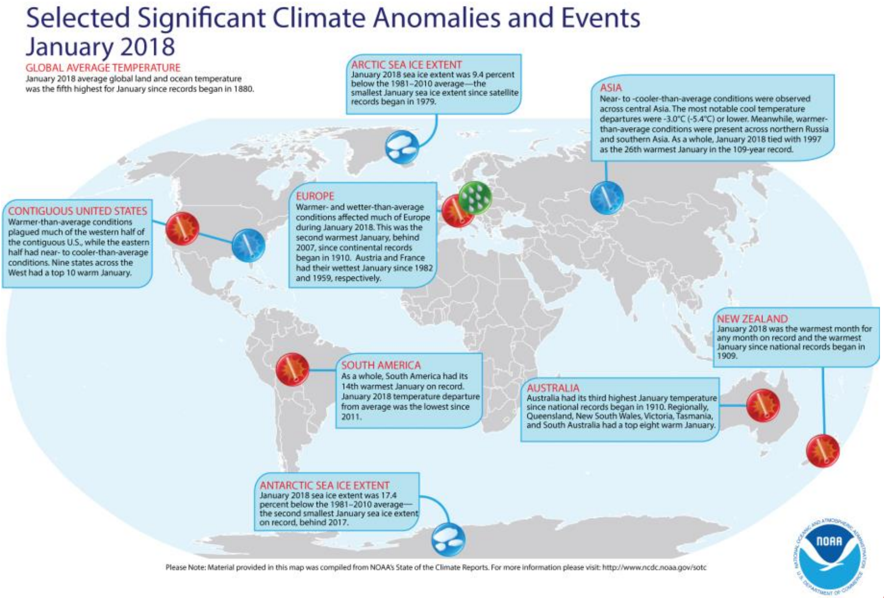


- average global temperature in 2017 was the second highest on record – after 2016
- 41st consecutive year of average global temperatures above the 20th Century mean
- Rate of increase of global average temperature unprecedented

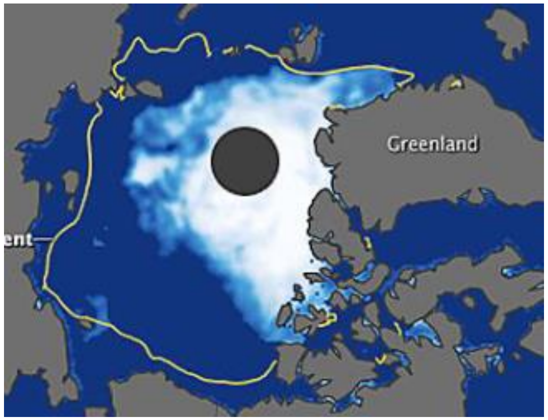
'…we are seeing remarkable changes across the planet that are challenging the limits of our understanding of the climate system. We are now in truly uncharted territory'

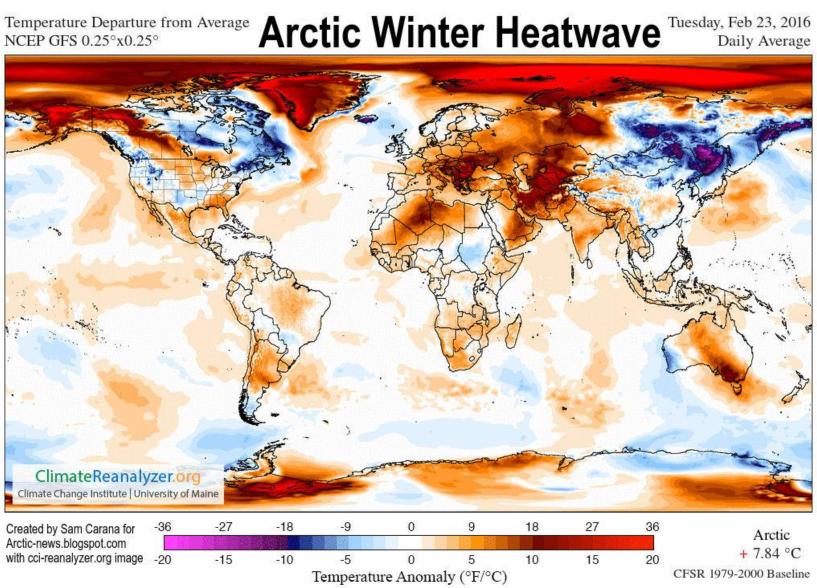
David Carlson, Director of WMO World Climate Research Program. (2017)

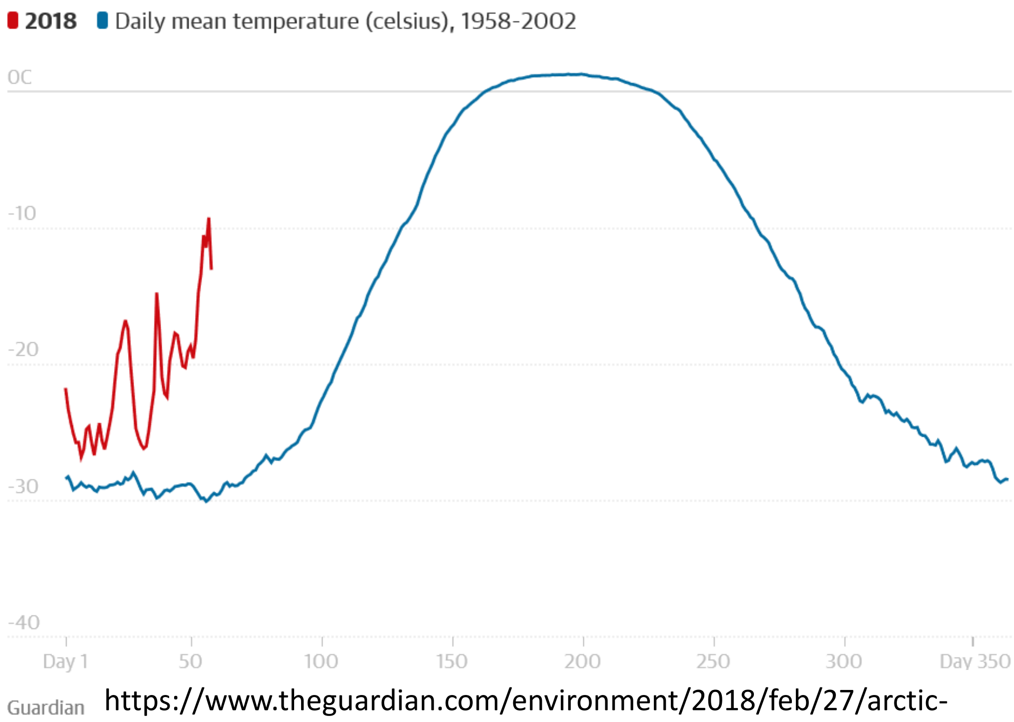
Climatic Anomalies Multiply



the Arctic Barometer







https://www.theguardian.com/environment/2018/feb/27/arctic-warming-scientists-alarmed-by-crazy-temperature-rises

http://arctic-news.blogspot.be/2016/02/arctic-winter-heatwave.html

UNFCC COP 21 Conference on Climate Change
December 2015

PARIS2015
UN CLIMATE CHANGE CONFERENCE
COP21·CMP11

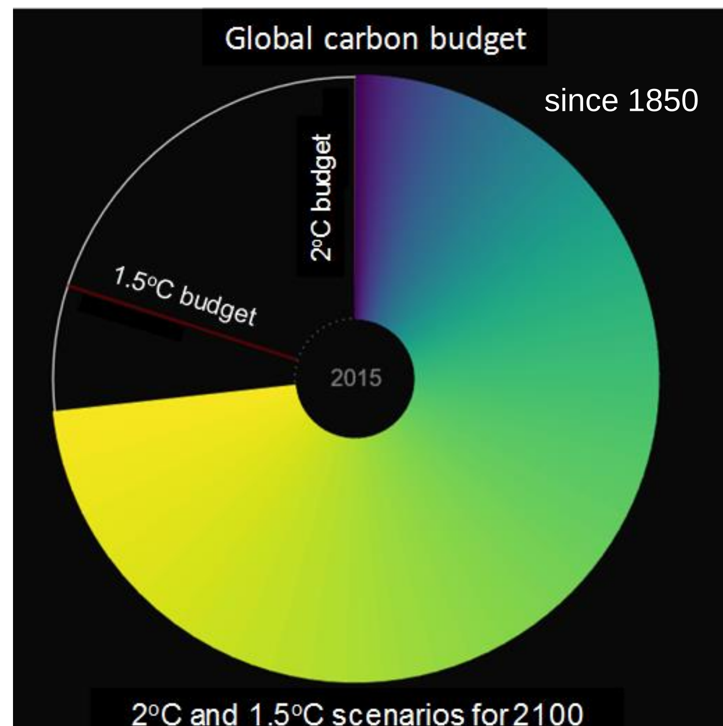
Bottom-up rather top-down approach to securing country commitments
Intended Nationally Determined Contributions (INDCs)

International agreement to keep average global temperature '*well below*' 2°C above pre-industrial times and '*endeavor to limit*' it to 1.5°C – **but already 1.1°C above 1850 temperature**

No legal sanction on countries failing to meet targets

COP21 commitments still lead to 3.4°C increase by 2100

US withdrawal from Paris Accord: *not till 2020*



Source: Ed Hawkins http://www.climatechangenews.com/2016/07/27/spiral-tastic-climate-change-in-three-animations/

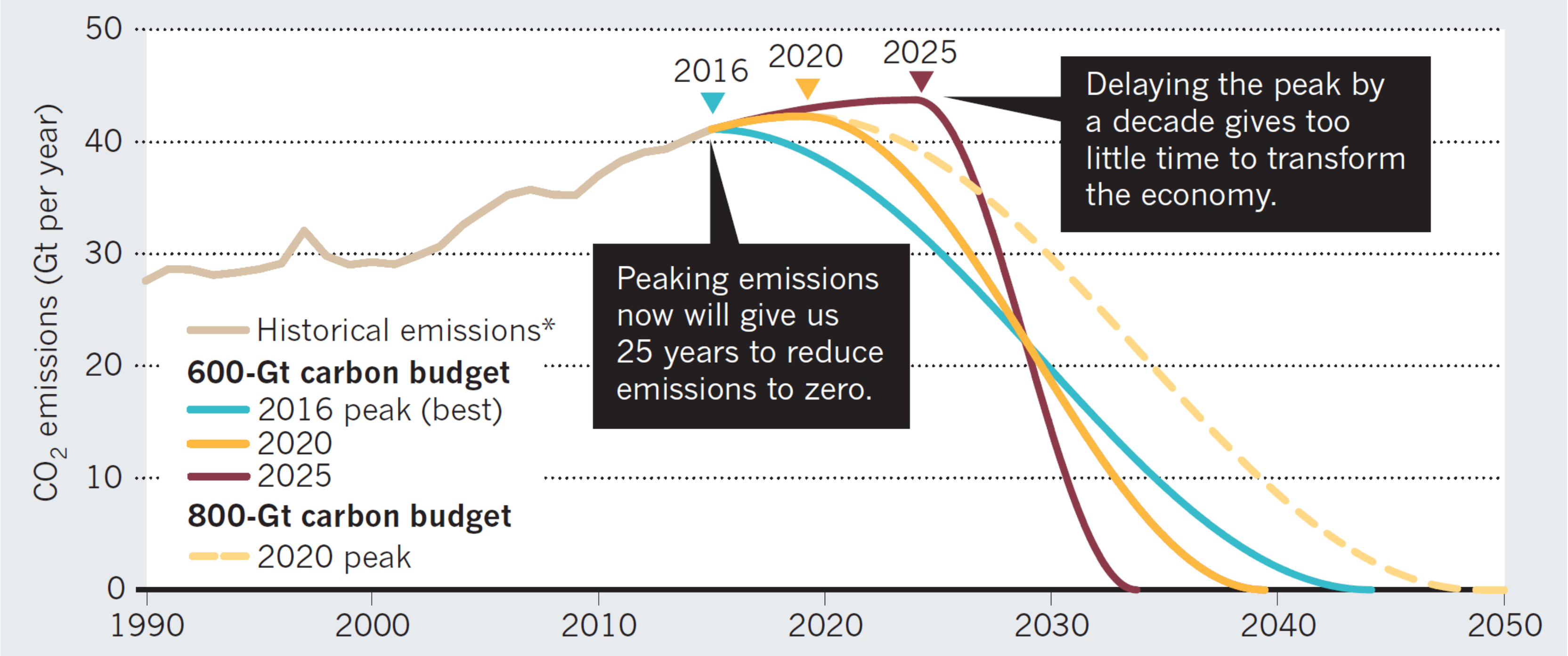
How much more CO_2 can we emit within COP21 temperature limits?

66% probability of staying within 2ºC limit total CO_2 emissions by 2100 to 1000Gt CO_{2e} (Intergovernmental Panel on Climate Change)

At current emission rate (41 Gt/ann) – only 24 years to reach this limit

Figueres et al (2017) estimate only 600 Gt GHG capacity: *15 years of emissions at current rate*

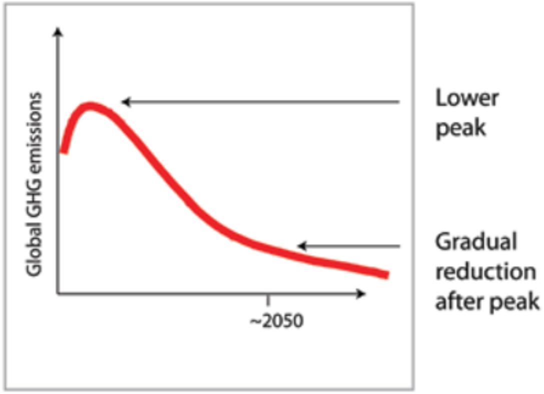
Annual emissions need to peak soon and drop sharply: *longer the delay steeper the decline*

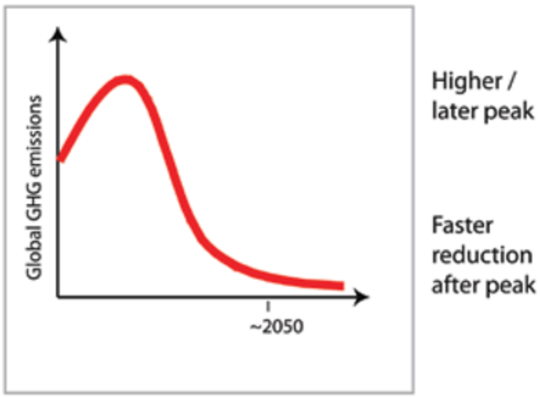


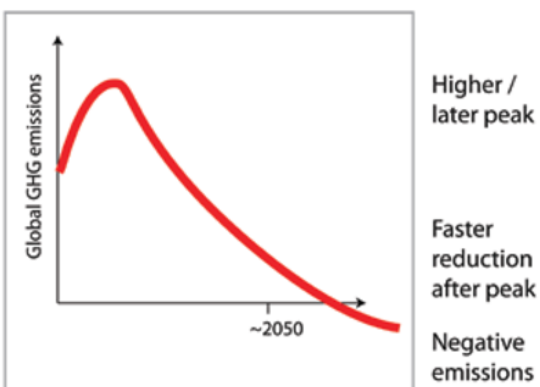
Source: Figueres et al, *Nature Climate Change* June 2017

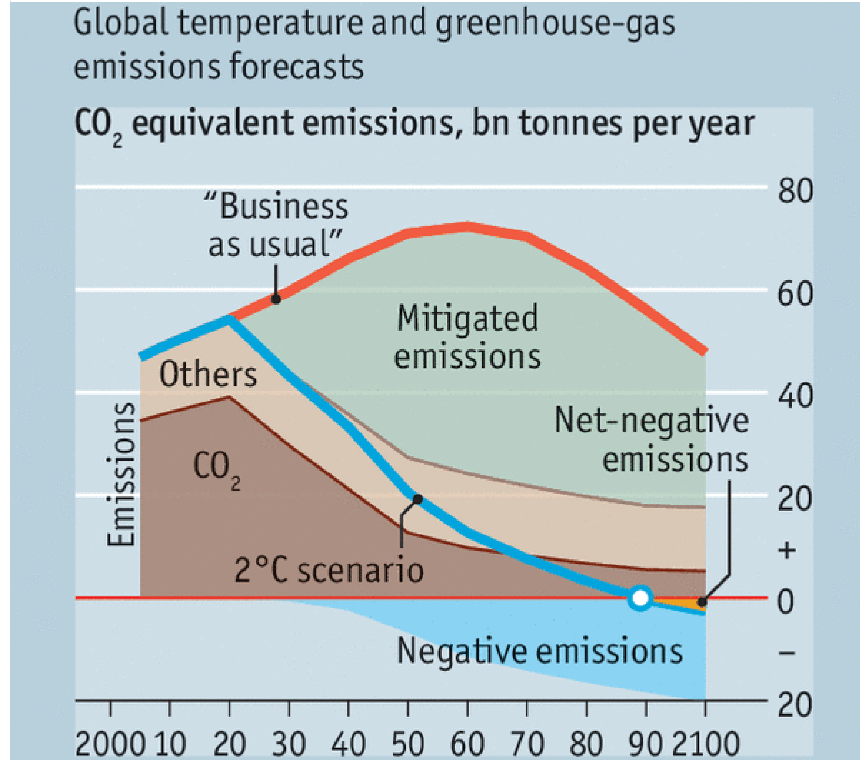
https://rael.berkeley.edu/wp-content/uploads/2017/06/Figueres-ThreeYearstoSafeguardOurPlanet-Nature-2017_full.pdf

Over-shooting carbon budgets – *reliance on negative emissions*





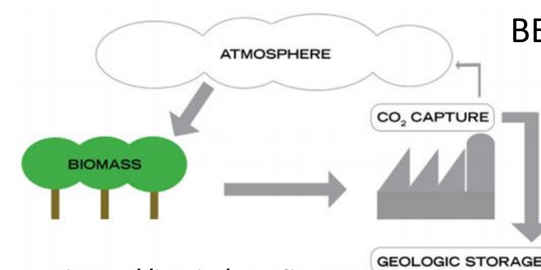




Economist 16 Nov 2017

Bio-energy with carbon capture and storage

BECCS

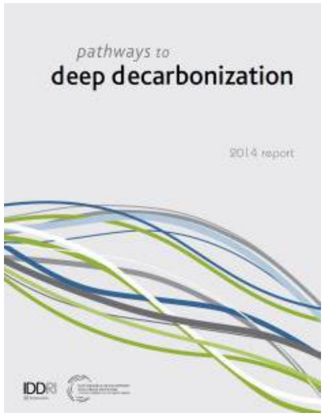


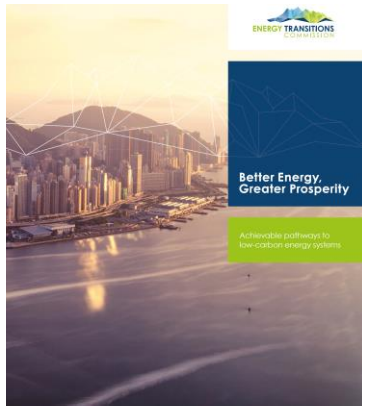
http://bit.ly/2p2flCO

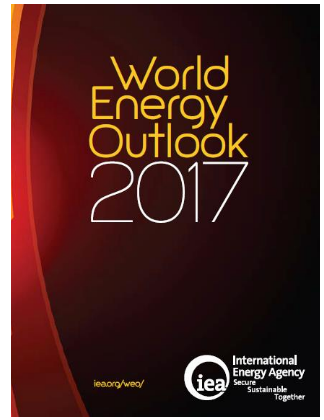
'negative emission technologies may have a useful role to play but, on the basis of current information, not at the levels required to compensate for inadequate mitigation measures' (EASAC, 2018)

Contribution of Logistics to Climate Change

- Freight transport 7-8% of energy-related CO_2 emissions
- Freight transport responsible for round 90% of all logistics emissions
- Little data on '*logistics buildings*' around 10-12% of logistics emissions



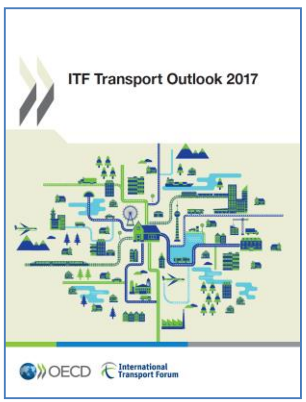




a '*hard to mitigate sector*'

Heavy dependence on fossil fuel

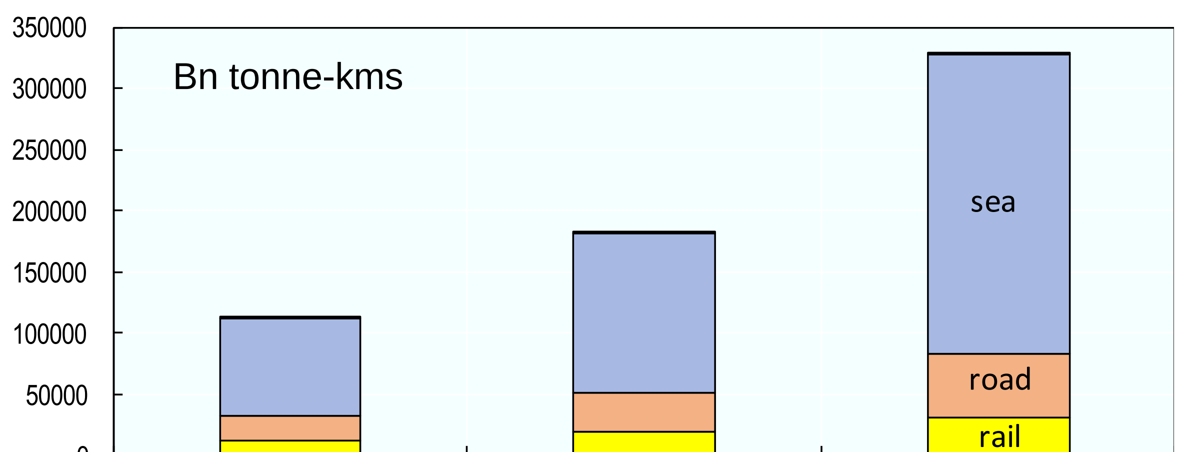
High forecast growth rate



OECD / ITF Transport Outlook (2017):

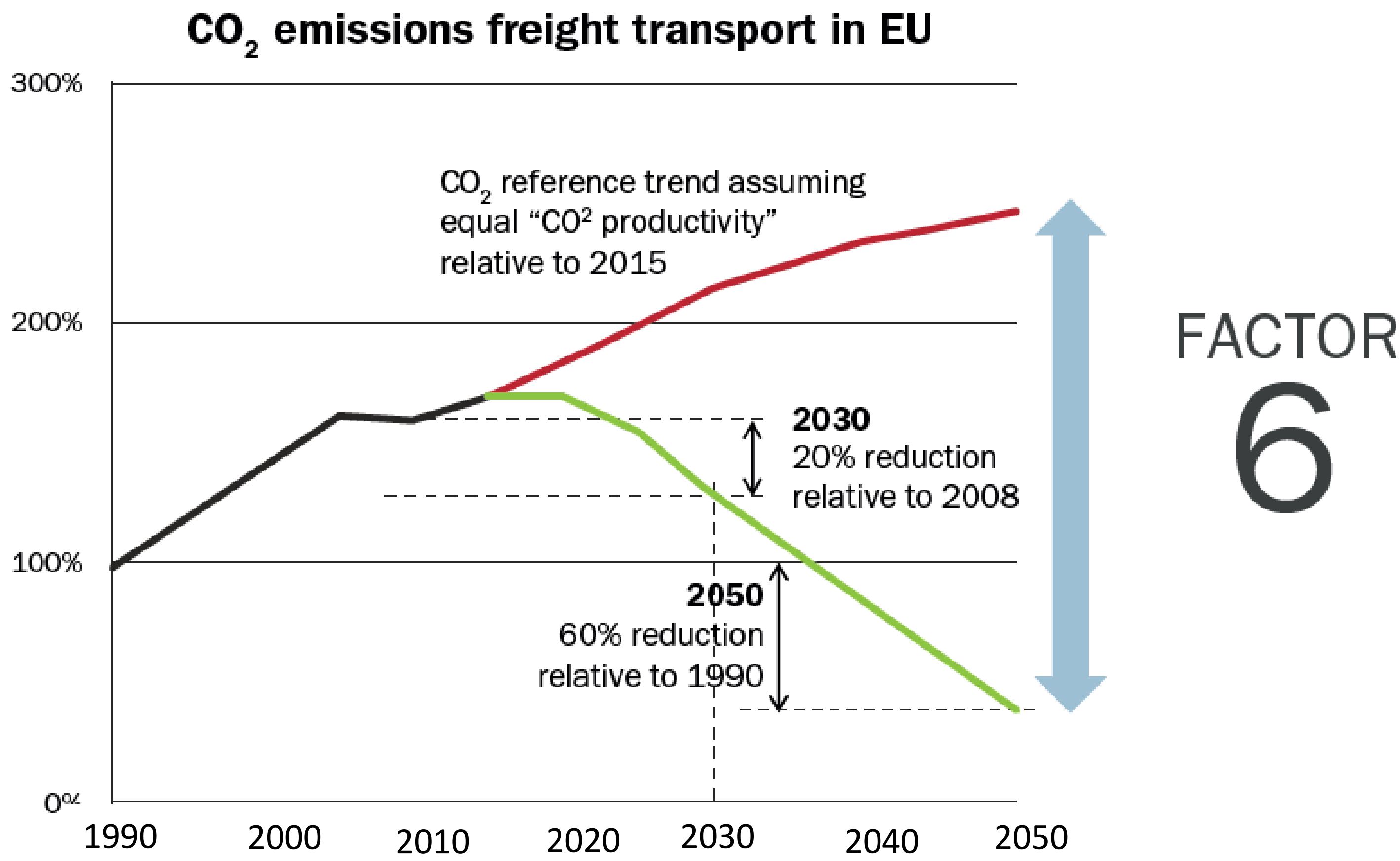
3x increase in freight tonne-km between 2015 and 2050

Freight transport emissions would rise from 3.2 to 5.7 Gt CO_{2e}



Meeting EU 2011 Transport White Paper CO_2 Target for 2050

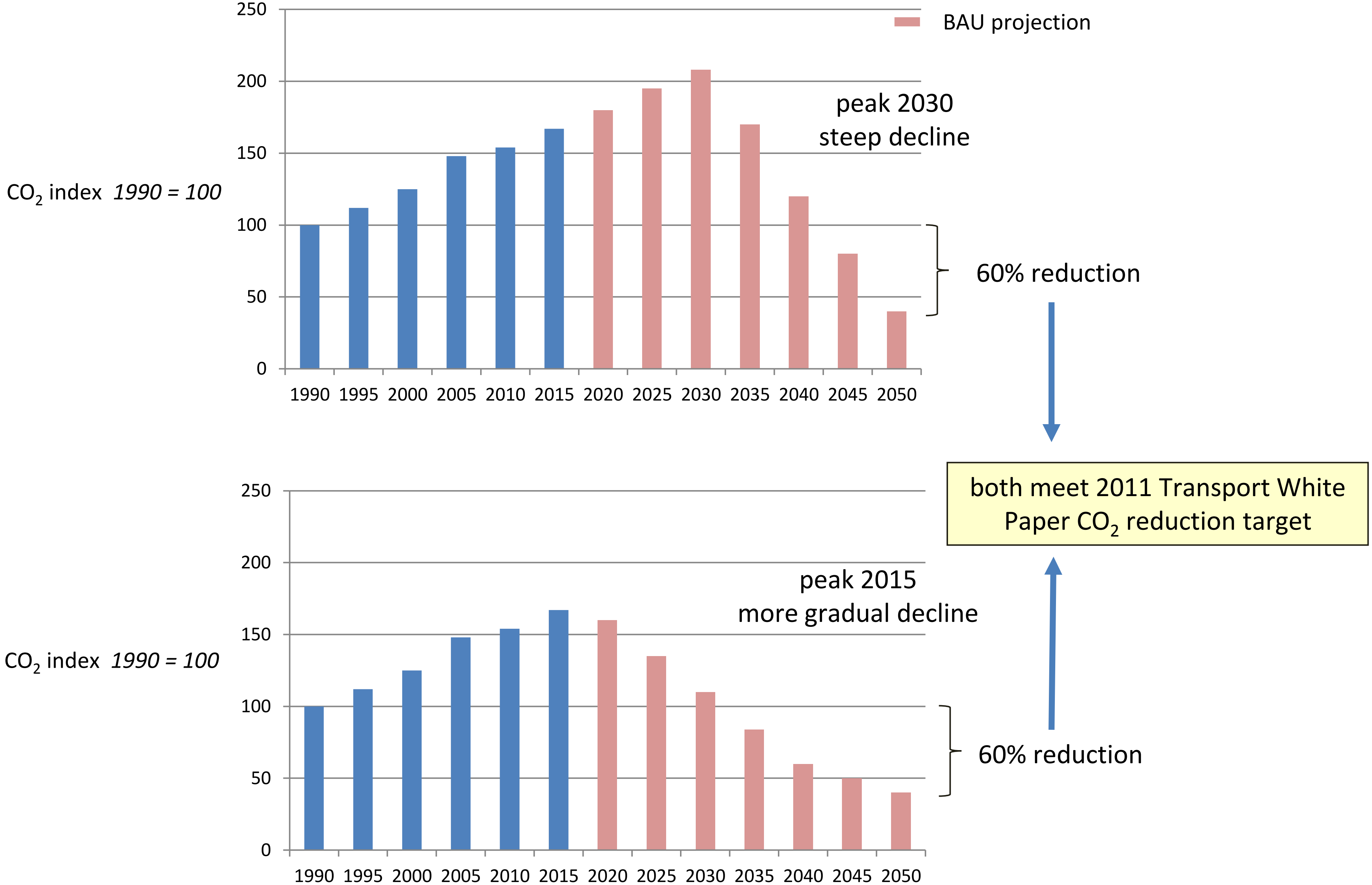
Reduction in carbon intensity need to achieve 60% cut in total freight-related emissions



83% reduction

Source: Smokers et al. (2017). *Decarbonising Commercial Road Transport*. Delft: TNO.

CO_2 emission reduction profiles for European freight transport



cumulative emissions 2015-2050: 34% lower

Deriving carbon reduction targets for logistics

corporate carbon intensity targets vs governmental absolute carbon reduction targets

SCIENCE BASED TARGETS
DRIVING AMBITIOUS CORPORATE CLIMATE ACTION

14% TRANSPORT

Other transport	Other transport
Aviation	Aviation
Rail passenger transport	Rail passenger transport
Heavy road passenger transport	Heavy road passenger transport
Light road passenger transport	Light road passenger transport

Freight is in the residual ‘Other transport’ category

SBT team could find ‘*no activity information*’ for freight in the IPCC and IEA reports – relied on monetary surrogates

Definition of Trucking
‘*Companies providing primarily goods and passenger land transportation Includes vehicle rental and taxi firms.’*

Need ambitious short, medium and long term targets

Preferably based on bottom-up, time-phased analysis

Deutsche Post DHL Group commits to zero emissions logistics by 2050

- Ambitious interim goals for carbon efficiency, local emissions, green customer solutions and employee engagement by 2025
- Previous climate protection target achieved ahead of schedule
- Frank Appel: “The decisions we make today will determine how our children live 30 years down the line.”

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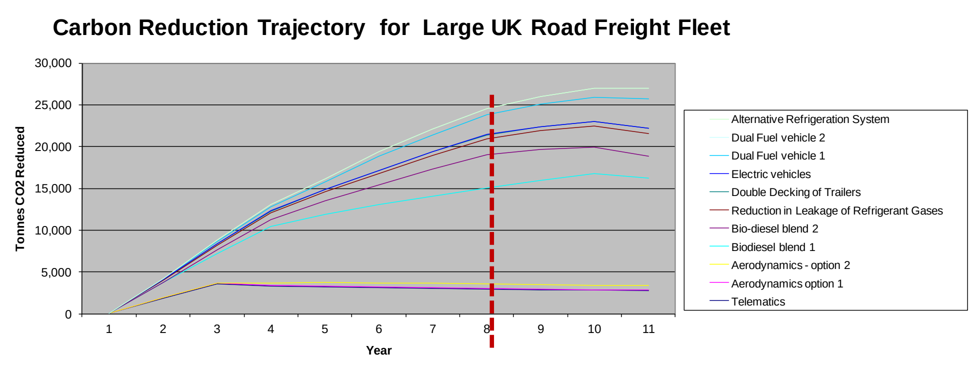
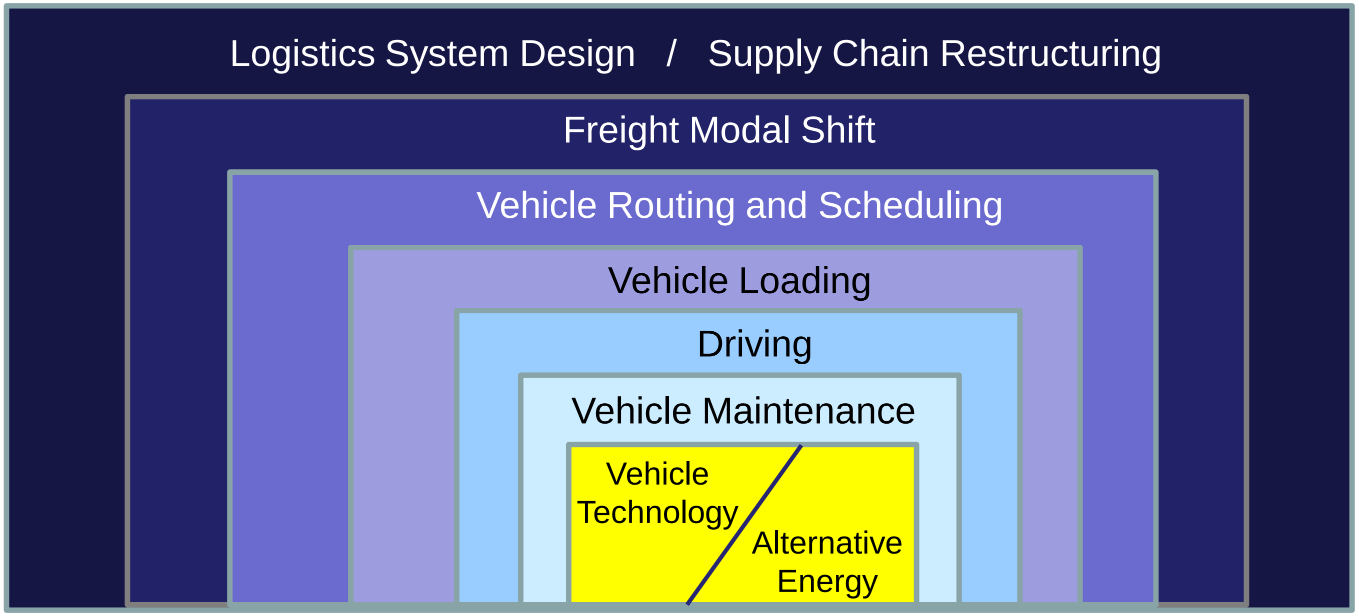
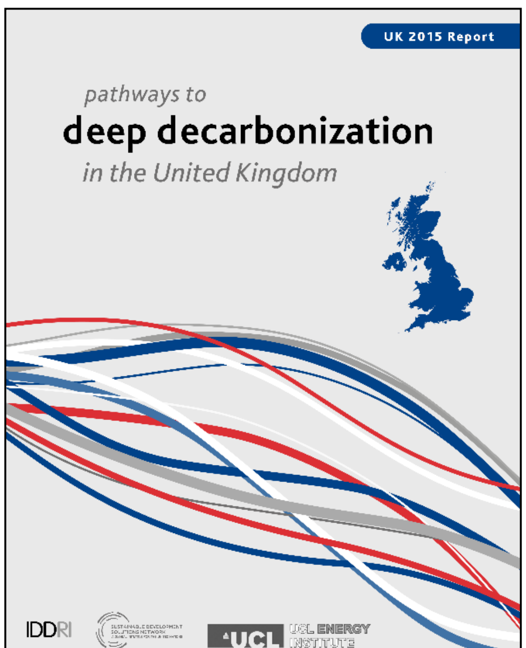
Deutsche Post DHL Group, the world's



Beware: not all decarbonisation measures are mutually-reinforcing and cumulative

Scoping the Decarbonisation of Freight Transport

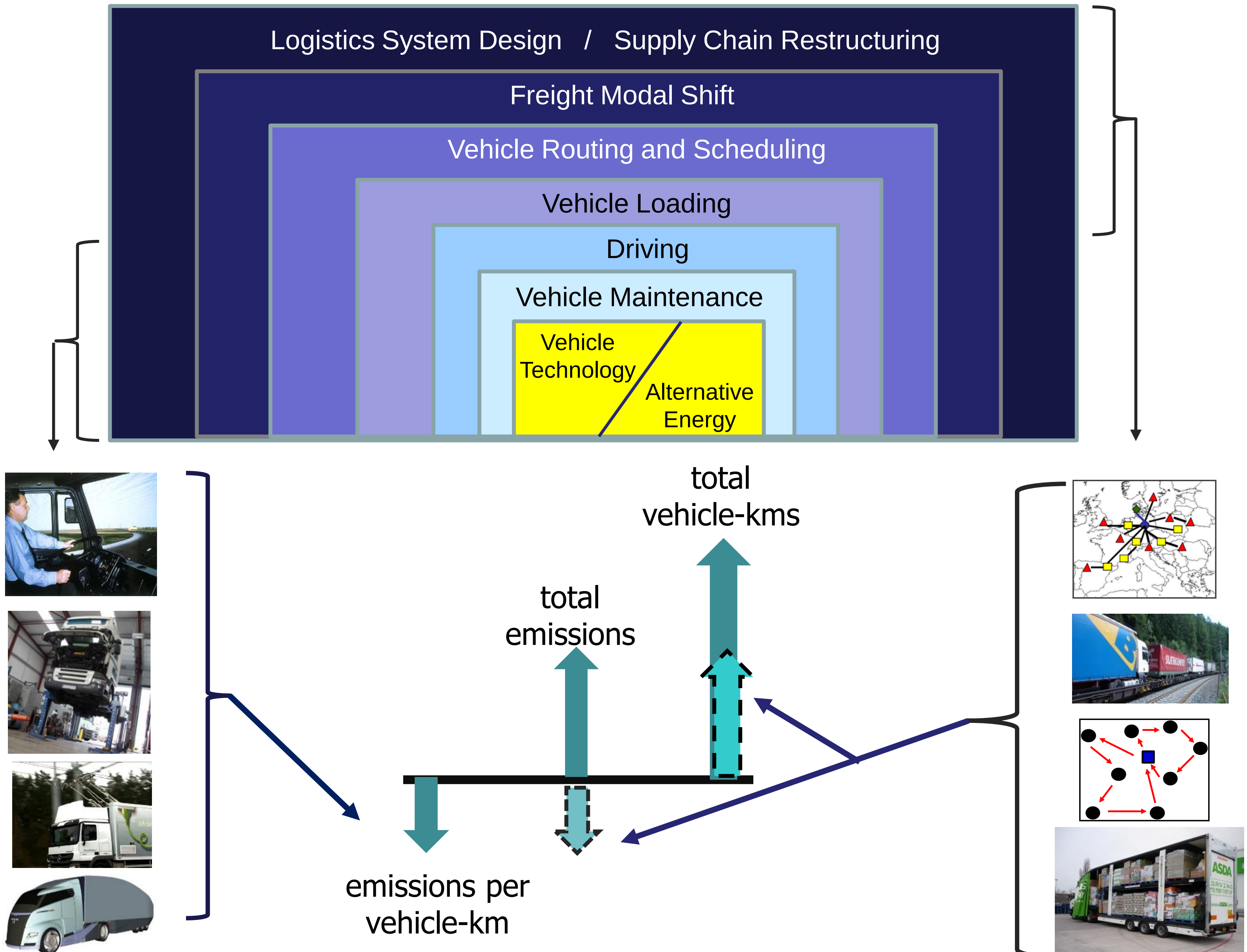




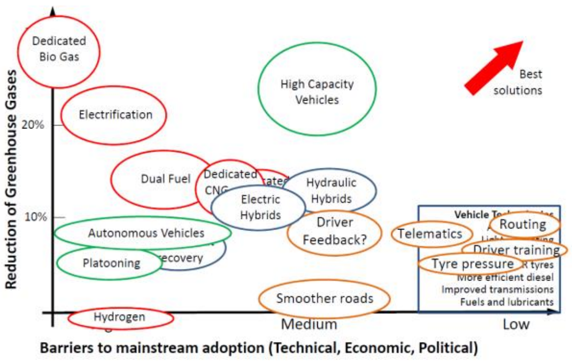
decarbonisation of UK road freight to be '*based on a shift to hydrogen-fuelled vehicles in the long term, with compressed natural gas (CNG) vehicles playing an important transitioning role*'.

vehicle and fuel school of logistics decarbonisation

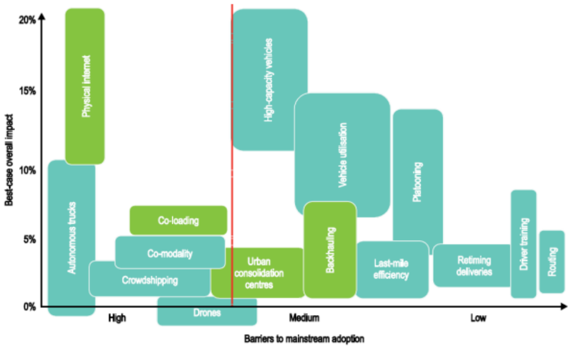
Scoping the Decarbonisation of Freight Transport



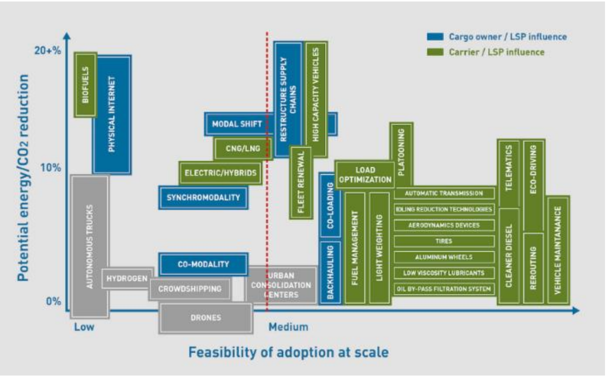
Road freight decarbonisation measures: *abatement – implementation graphs*



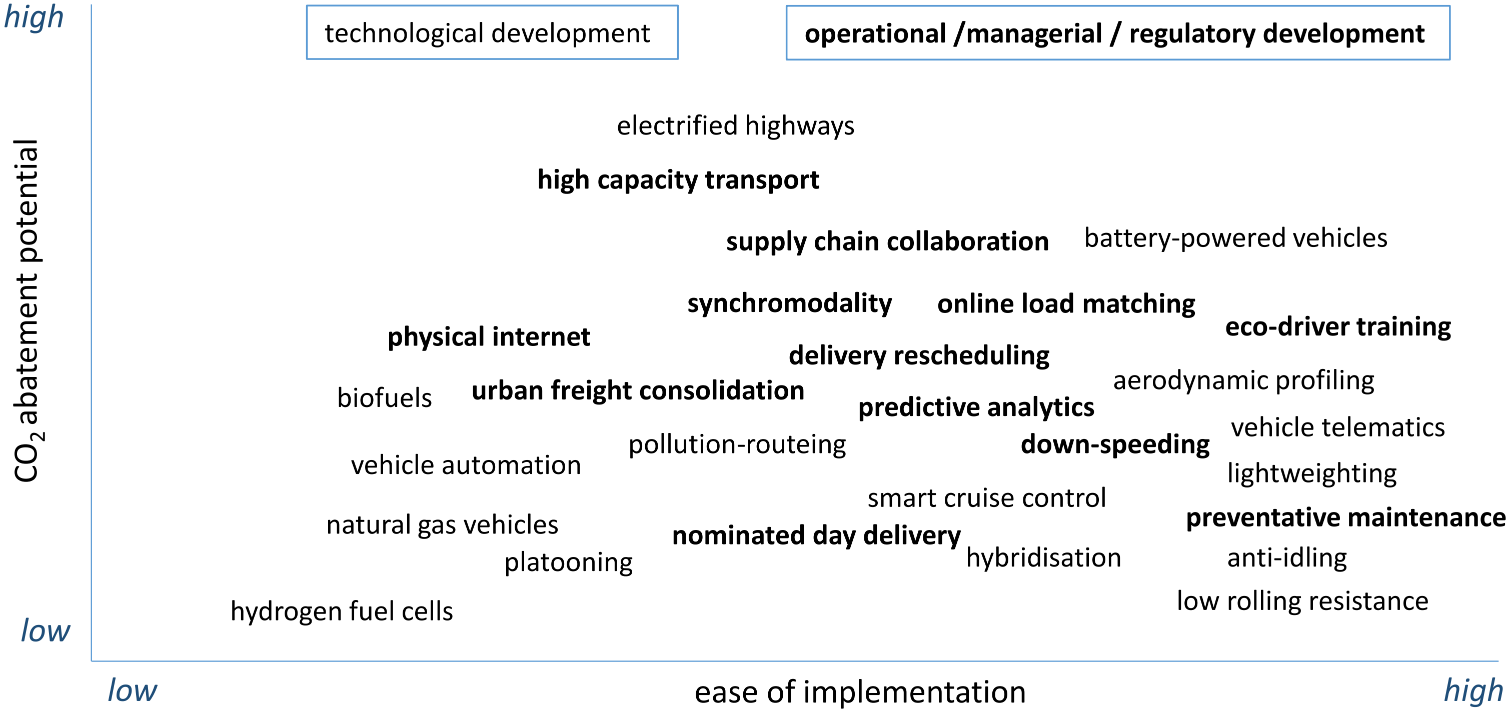
Professor Cebon



International Energy Agency

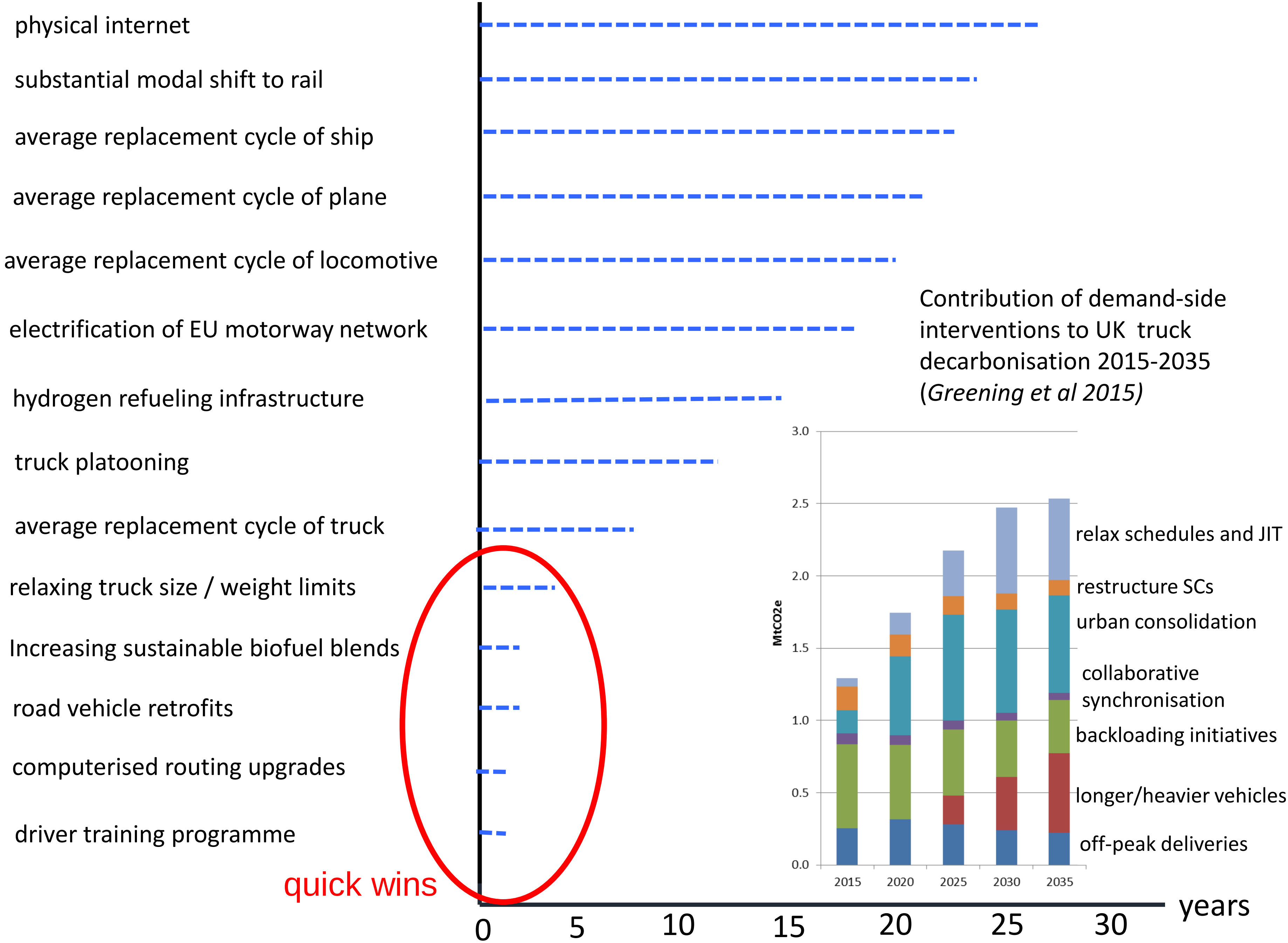


Smart Freight Centre



Source: McKinnon 2018

Time Dimension in Logistics Decarbonisation (indicative time-scales)



Five Sets of Decarbonisation Initiatives for Freight Transport

Reduce Demand for Freight Transport

Shift Freight to Lower Carbon Transport Modes

Optimise Vehicle Loading

Increase Energy Efficiency of Freight Movement

Reduce the Carbon Content of Freight Transport Energy

Restrain the Growth in Demand for Freight Transport

'De-growth' – reaching '*peak stuff*'?

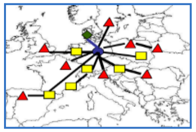
– substitute experiences for physical goods

– need to constrain consumption?

Dematerialisation: improve '*material efficiency*':

- Increase modularisation and remanufacturing: *circular economy*
- Digitisation of physical products: *consignments to electrons*
- Designing products with less material: *miniaturisation, lightweighting*
- 3D Printing: *less material, less wastage, eliminating supply chain links*

Restructuring of supply chains



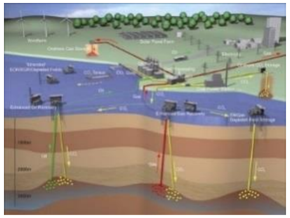
- relocalize production / sourcing
- decentralize inventory
- reversal of key business trends
- high carbon-mitigation costs

Fossil fuel phase-out

- 60% of trade in raw materials
- G7 fossil-fuel free by 2100
- Constructing renewable energy infrastructure is material- and transport-intensive

New freight growth sectors?

carbon capture and storage

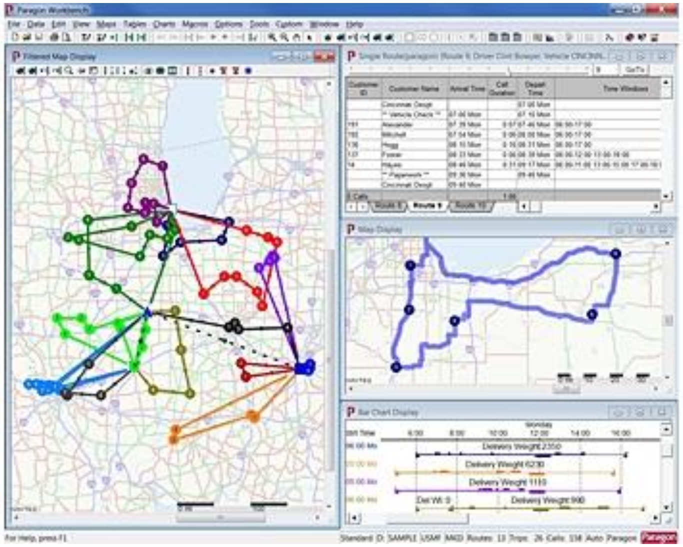


air conditioning

adaptation of infrastructure to climate change

resettlement of populations

Optimising Vehicle Routeing



Can reduce the distance travelled by freight consignments – *cutting transport intensity*

Yields economic and environmental benefits – *‘win – win’ option*

No adverse impact on economic development

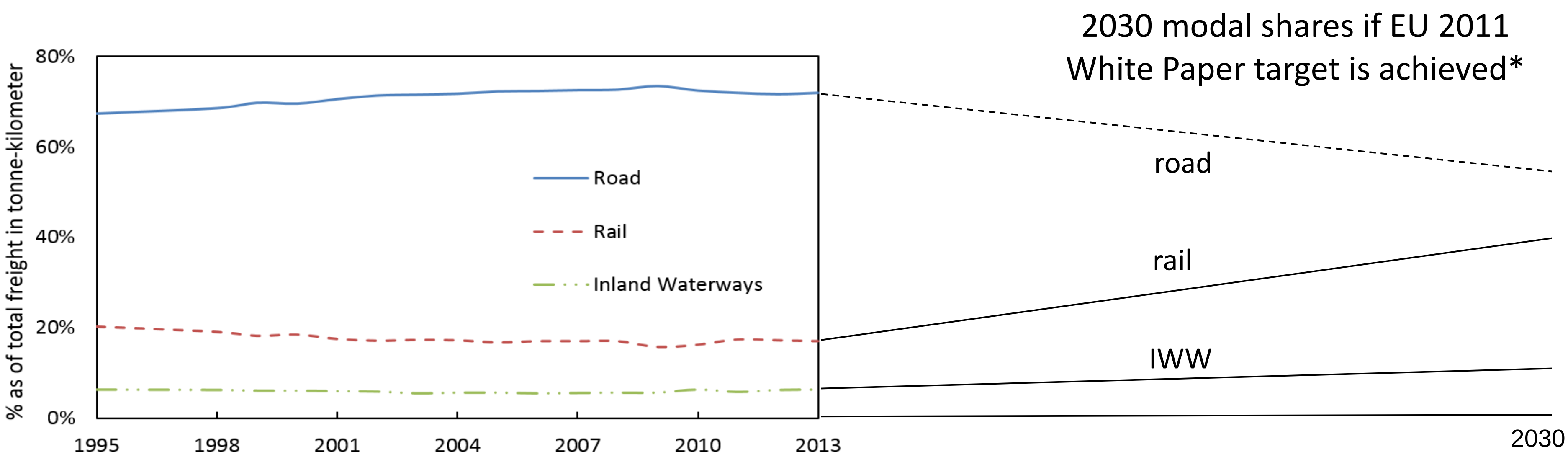
Use of computerised vehicle routing and scheduling (CVRS) software to optimise routes

Widely adopted technology in developed countries but low levels of market penetration in emerging markets

CVRS being upgraded as vehicles becoming more intelligent and connected – *dynamic re-routing of vehicles*

Big Data and use of predictive analytics enabling carriers like UPS to increase efficiency of delivery – customer service, cost and service benefits

Prospects of a Major Modal Shift?



*based on analysis by Tavasszy and van Meijeren (2011)

strategic corridors

intermodal hubs

Synchromodal scheduling

	Location	Cost	Travel time	Distance	Transportmode
1	Karlsruhe Industriegebiet	0.00	10:16	0.0	TM_ROAD
2	Wörth am Rhein Hafen	63.00	10:58	29.5	LOAD_ROAD_RAIL
3	Wörth am Rhein Hafen	63.00	2 16:00	29.5	TM_TTN_RAIL
4	Hamburg CTB Burchardkai	301.00	3 14:15	722.5	LOAD_RAIL_SHORTSEA
5	Hamburg CTB Burchardkai	301.00	7 17:00	722.5	TM_TTN_SHORTSEA
6	Moss Container Terminal	400.00	10 09:00	1,564.5	LOAD_SHORTSEA_ROAD
7	Moss Container Terminal	400.00	10 09:30	1,564.5	TM_ROAD

Wider supply chain application of synchromodality principle

Decline in coal and oil traffic

Change in rail freight commodity mix

Need to redefine modal shift target: *choice of metrics*

differing rates of modal decarbonisation

reducing the carbon benefits of switching mode?

Improving Vehicle Utilisation

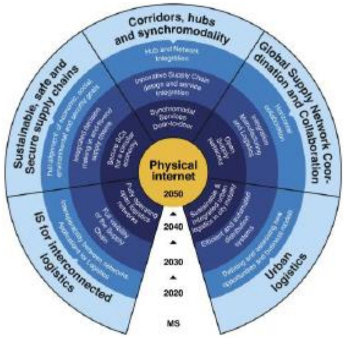
Constraints on loading

- **Demand fluctuations**
- **Uncertainty about transport requirements**
- **Geographical imbalances in freight flows**
- **Limited knowledge of backloading opportunities**
- **Vehicle size and weight restrictions**
- **Unreliable delivery schedules**
- **Just-in-Time delivery**
- **Nature and size of packaging / handling equipment**
- **Limited storage capacity at destination**
- **Incompatibility of vehicles and products for backloading**
- **Poor coordination of purchasing, sales and logistics**

Online freight procurement

High capacity transport

Logistical collaboration



Physical internet

Improve Energy Efficiency in the Freight Transport Sector

vehicle design: *new build + retrofits*

vehicle operation: *IT , training, monitoring*

eco-driver training

telematic monitoring

platooning

automation

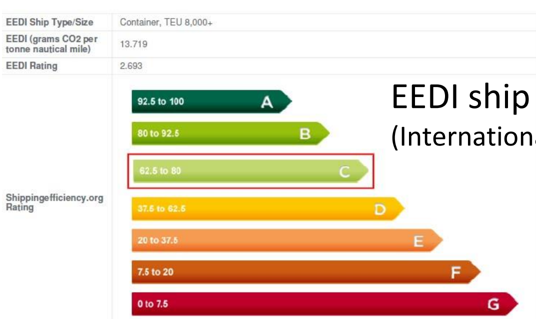
fuel economy standards: *applied to trucks and ships*

Fuel Economy Standards for Heavy Duty Vehicles

	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Japan				Phase 1										Phase 2
U.S.			Phase 1					Phase 2						
Canada			Phase 1					Phase 2						
China	Phase 1		Phase 2						Phase 3					
EU						Certification, Monitoring, Reporting								
India									Phase 1					
Mexico									Phase 1					
S. Korea									Phase 1					

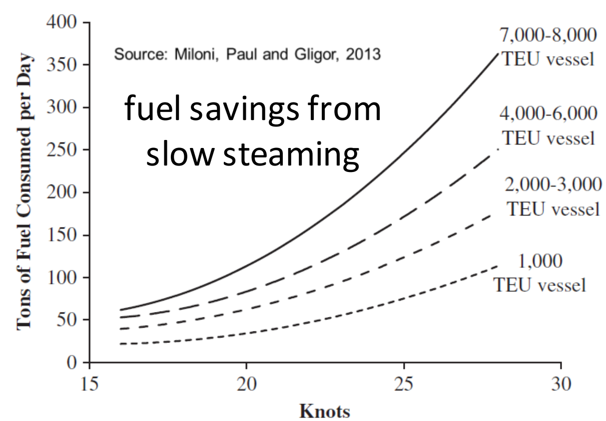
Hashed areas represent unconfirmed projections of the ICCT

Source: ICCT (2015)



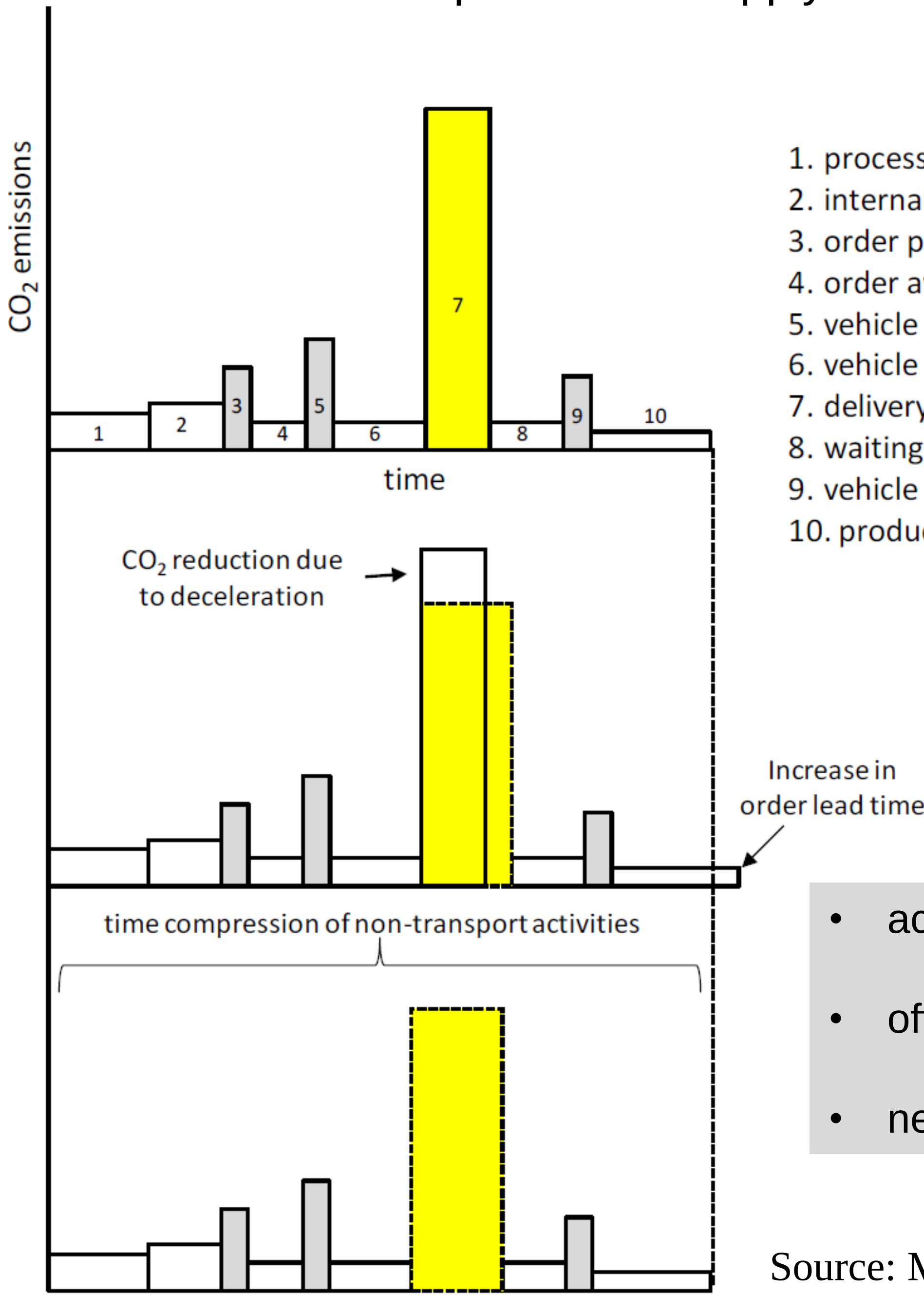
EEDI ship efficiency ratings
(International Maritime Organisation)

business practice: e.g. *deceleration*



Wider case for transport deceleration ?

Relationship between Supply Chain CO_2 Emissions and Time

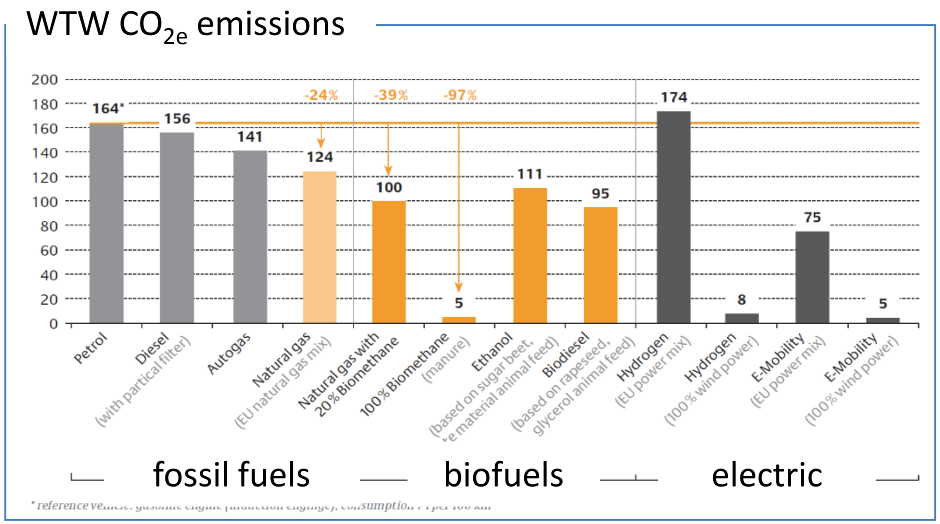


1. processing of inbound order
2. internal administration / checks
3. order picking
4. order awaiting loading
5. vehicle loading
6. vehicle waiting time
7. delivery
8. waiting time at reception point
9. vehicle off-loading and put-away
10. product storage prior to use / sale

- accelerate internal processes
- offset longer transit times
- net CO_2 saving within fixed lead time

Source: McKinnon (2016) *Transport Reviews*

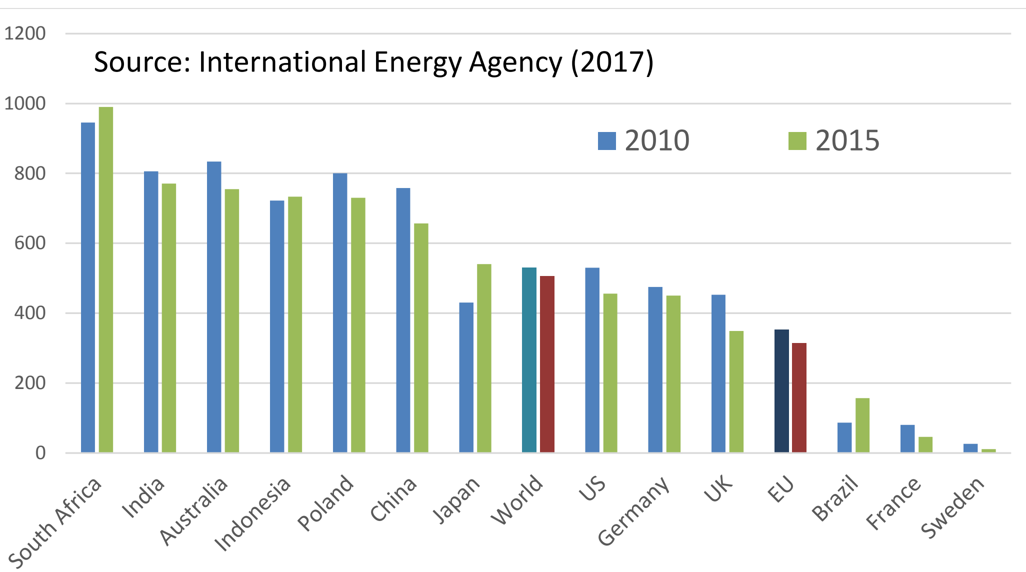
Switch to Cleaner, Low Carbon Energy



biofuel fuels: *slow uptake*

- uncertainty about net GHG impact
- limited supply of biofuels
- inter-sectoral competition for supplies
- lack of refuelling infrastructure
- '*methane slip*' problem

CO_2 benefits of freight electrification?



Carbon intensity of electricity generation (gCO_2 / kWh)

Short-term: *electrified rail*
local road delivery

- recharging infrastructure
- future battery performance
- E- vehicle price differential

Long-term:

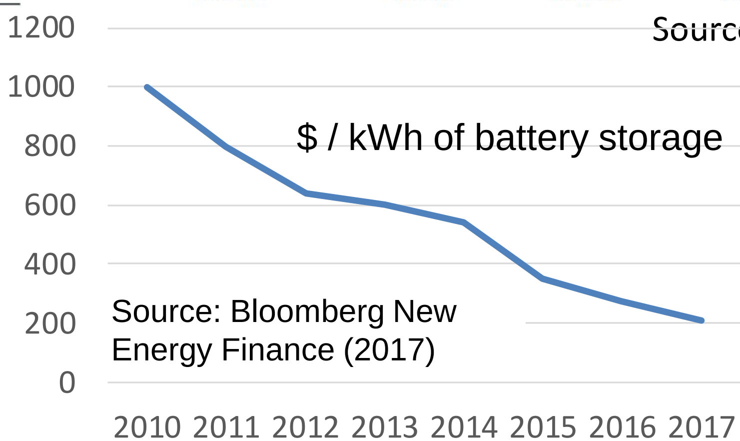
cold ironing of ships in port

electrified roads: Trials in Sweden, Germany and the US

Energy Efficiency and Cost of Different Methods of Electrifying Long Haul Road Freight

Pathway — 100 kWh 6c / kWh	Range Cost per km	Efficiency WTW	Example vehicle
Electric Road Systems e^- → Grid (incl. catenary) (96 kWh, 12 ct/kWh) → e^- → eTruck (Catenary-Hybrid) (1,6 kWh/km)	**60 km** 19 ct/km	77%	
Battery e^- → Grid (96 kWh, 10 ct/kWh) → e^- → eTruck (Battery) (2 kWh/km)	**48 km** 20 ct/km	62%	
Hydrogen e^- (93 kWh) → Electro-lysis η = 70% (65 kWh, 15 ct/kWh) → H_2 → H_2-network[1] (2 kWh; 65 kWh, 18 ct/kWh) → H_2 → CH_2- fuel station (5 kWh; 65 kWh, 20 ct/kWh) → $C.H_2$ → Fuel cell truck (2.7 kWh/km)	**24 km** 55 ct/km	29%	
Power-to-Gas e^- (98 kWh) → Electro-lysis η = 70% (69 kWh, 15 ct/kWh) → H_2 → Methanation η = 80% (55 kWh, 19 ct/kWh) → CH_4 → NG-network[1] (55 kWh, 20 ct/kWh) → NG → CNG-fuel station (2 kWh; 55 kWh, 22 ct/kWh) → CNG → Gas-truck (3.2 kWh/km)	**17 km** 70 ct/km	20%	

Source: German Ministry of Environment (quoted by Akermann, 2016)



TESLA gamechanger?

500 mile battery range
fast charging
autonomous
platooning-ready

Leveraging the decarbonisation parameters to achieve a Factor 6 reduction

30% modal shift road to rail

Rail improves energy efficiency by 50%
and reduces carbon intensity of energy by 50%

20% improvement in routeing efficiency

30% increase in loading of laden vehicles

30% reduction in empty running

50% increase in energy efficiency

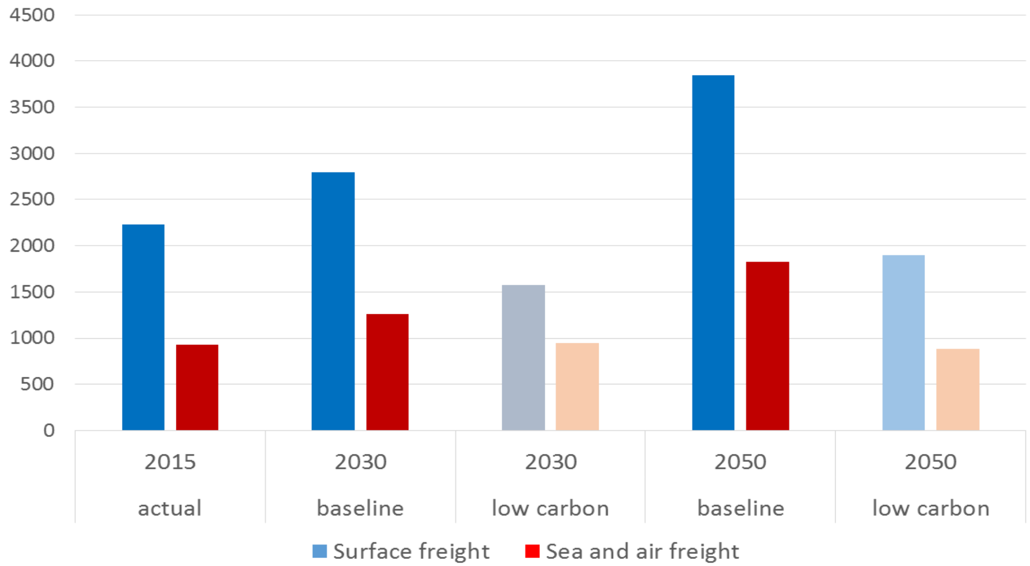
50% reduction in carbon intensity of the energy

achievable in 20-30 years ?

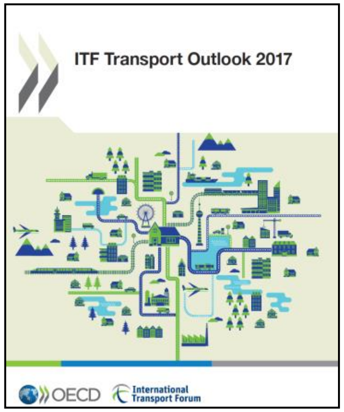
83% reduction in carbon intensity

Factor 6

Potential CO_2 reductions from freight transport: *grounds for optimism*?



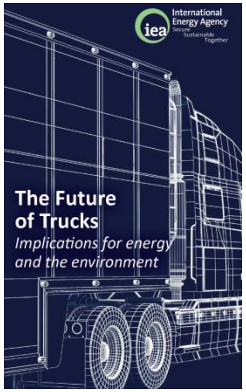
CO_2 emissions from freight transport: baseline trend vs low carbon scenario



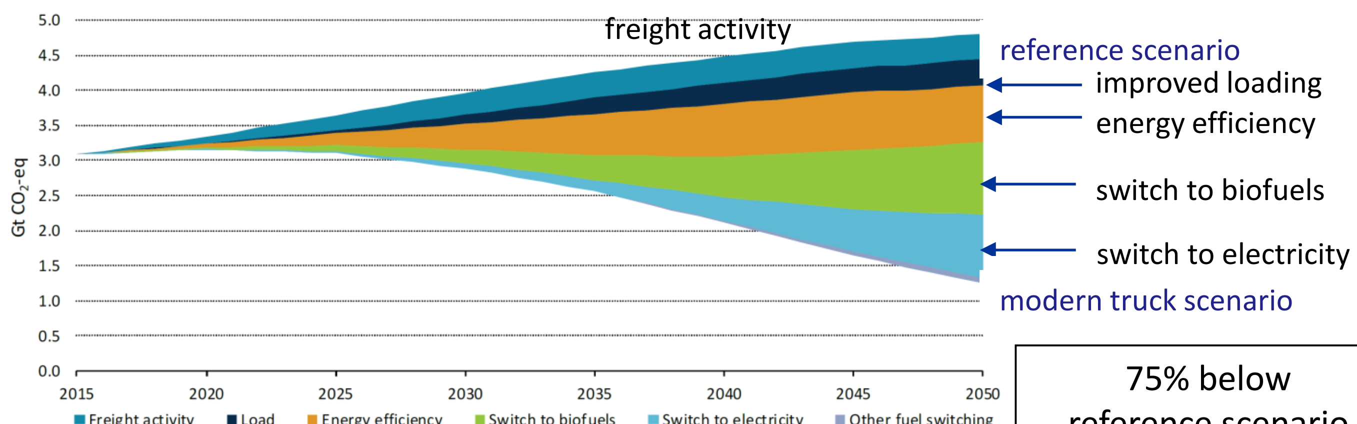
Reducing global average carbon intensity of freight transport from **28 gCO_2/tonne-km** to **8 gCO_2/tonne-km**

But total freight-related emissions in 2050 on **14% lower** than in 2015

CO_{2e} emissions from road freight transport: reference (i.e. baseline) scenario vs modern truck (i.e. low carbon) scenario



source: IEA (2017)



75% below reference scenario

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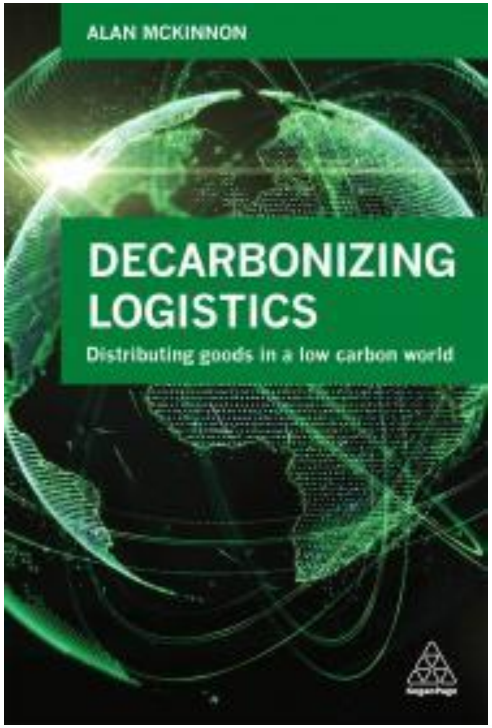

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