Decarbonizing Freight Transport:

A Review of Technical, Managerial and Operational Options

Professor Alan McKinnon

Kühne Logistics University

ITF / OECD Decarbonising Road Freight Workshop

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Urgency

Scoping

Uncertainty

Transferability

Need to convey new sense of urgency to logistics sector

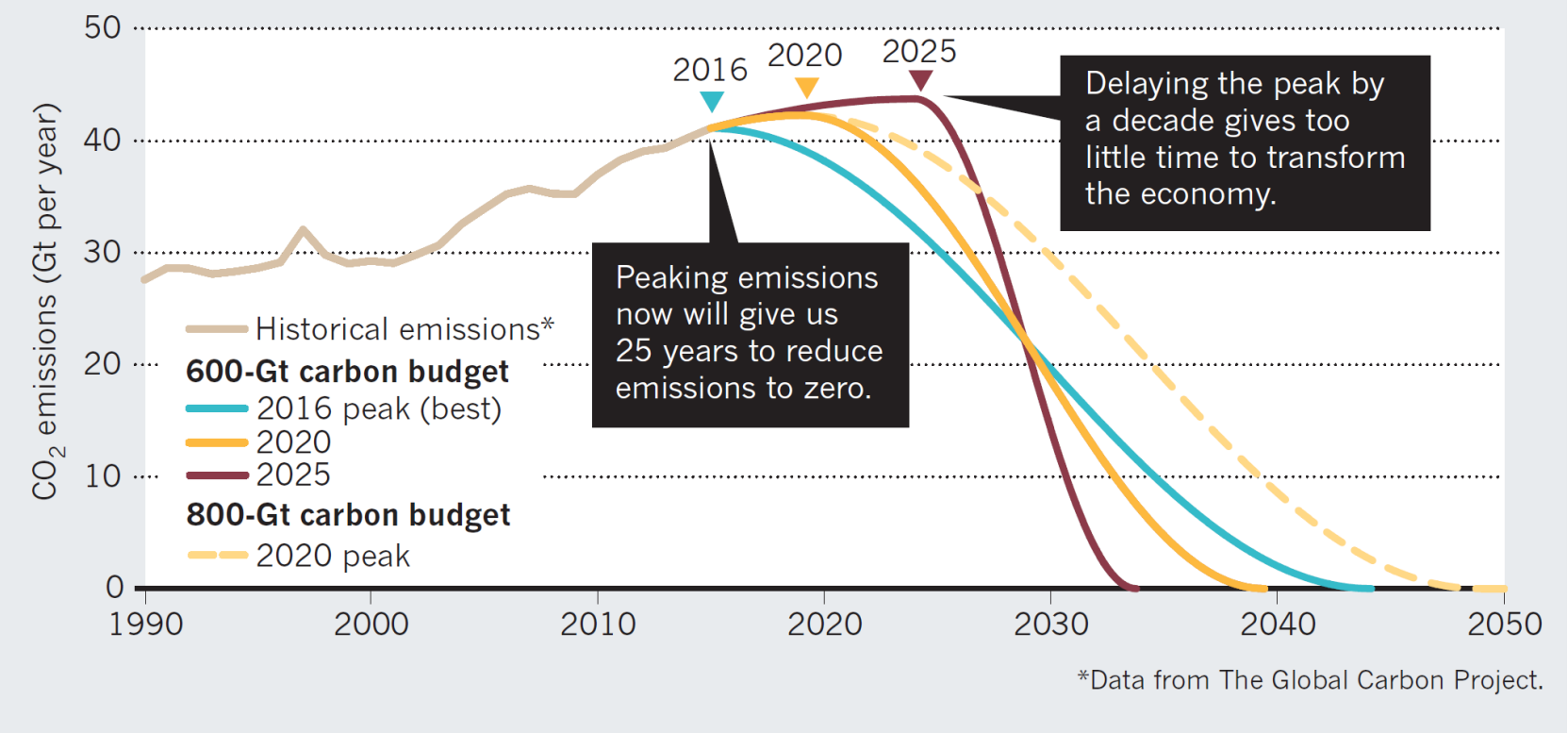
Forthcoming IPCC report emphasises importance of staying within 1.5°C

For 50% probability of staying within 1.5°C by 2100: *remaining carbon budget 750 Gt CO_2*

At current emission rate (41 Gt/annum) – only 18 years to reach this limit

- *road freight 2.4 Gt of energy-related CO_2 (IEA, 2017)*

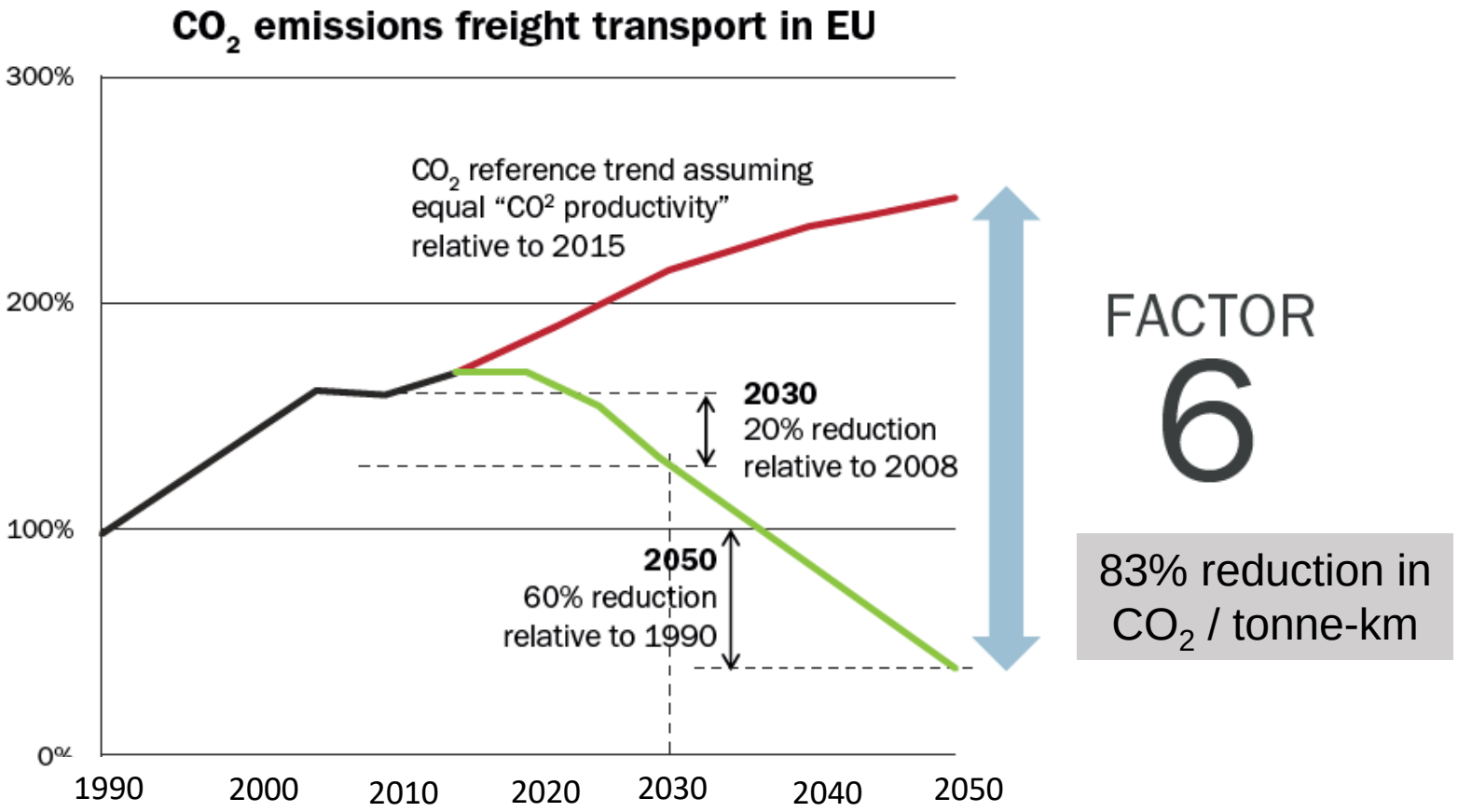
Annual emissions need to peak soon and drop sharply: *longer the delay steeper the decline*



Source: Figueres et al, *Nature* June 2017

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



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

Leveraging freight decarbonisation parameters to achieve a Factor 6 reduction by 2050

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

⬇

83% reduction in carbon intensity

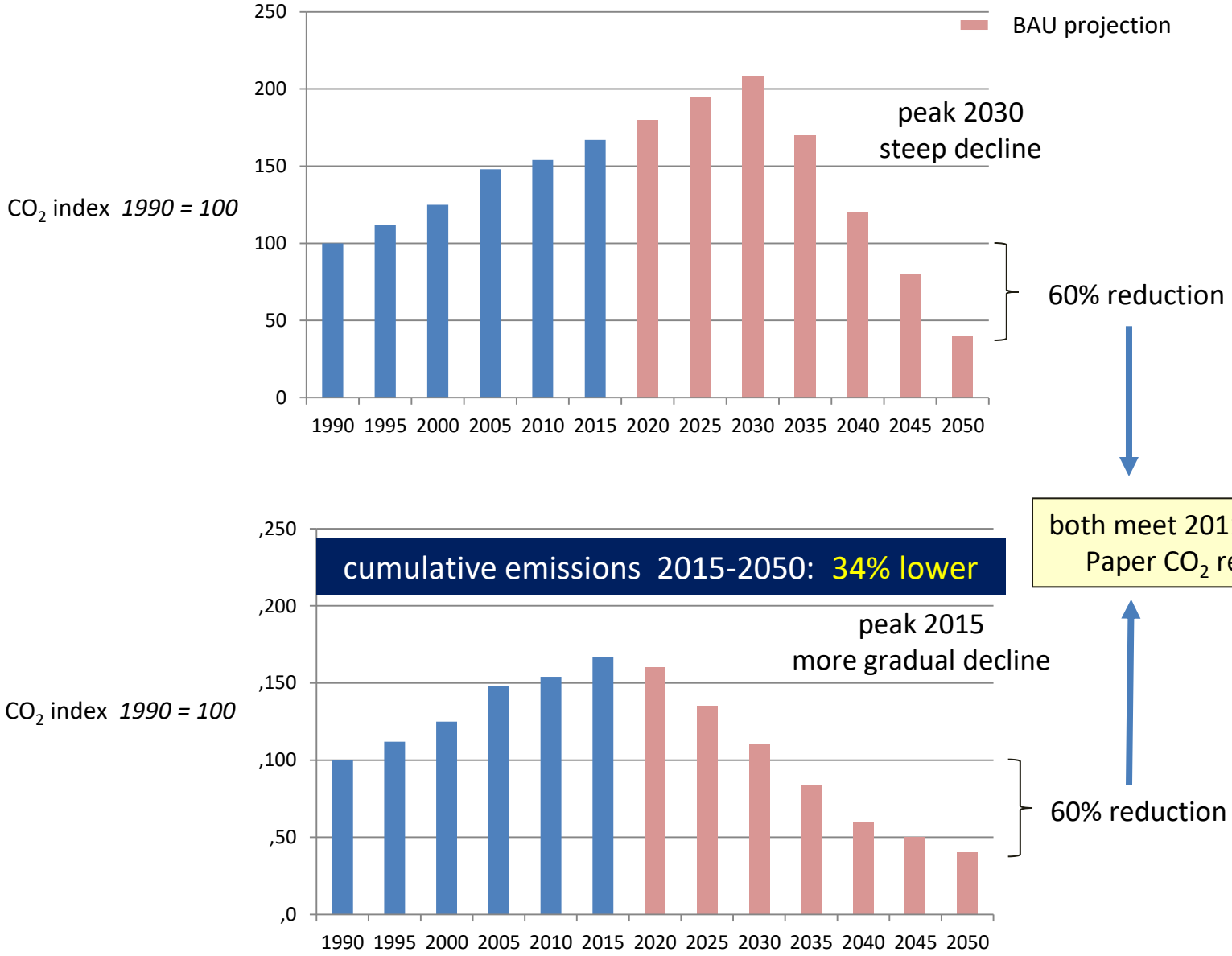
Factor 6

achievable in 20-30 years ?

may need to restrain forecast growth in demand for freight transport

EU wants to avoid '*curbing mobility*'

CO_2 emission reduction profiles for European freight transport



Source: McKinnon (2018) Decarbonizing Logistics

Implementation time for logistics decarbonisation options

physical internet

substantial modal shift to rail

new fleet of low carbon vessels

new fleet of low carbon planes

new fleet of low carbon locomotives

electrification of EU motorway network

hydrogen refueling infrastructure

truck platooning

average replacement cycle of truck

relaxing truck size / weight limits

Increasing sustainable biofuel blends

road vehicle retrofits

computerised routing upgrades

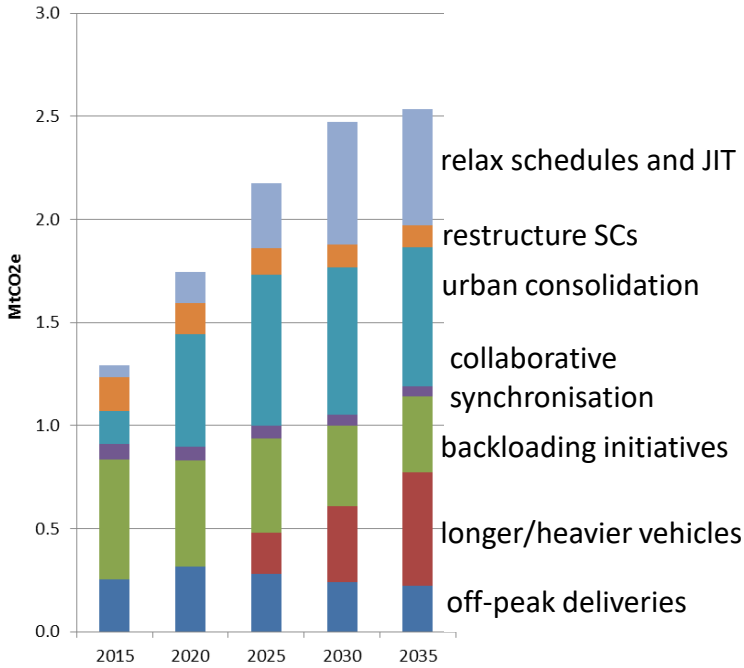
driver training programme

quick wins

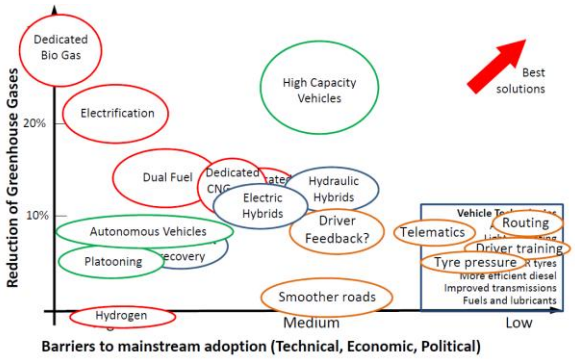
0 5 10 15 20 25 30 years

roadmapping

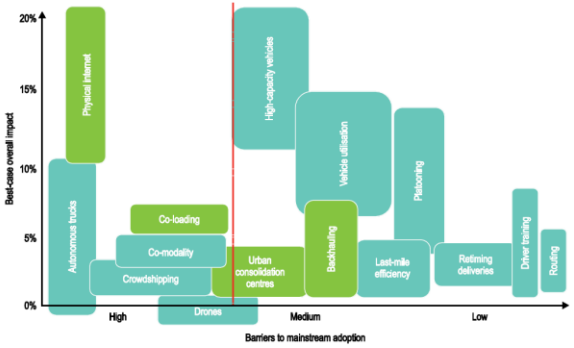
Contribution of demand-side interventions to UK truck decarbonisation 2015-2035 (*Greening et al 2015)*



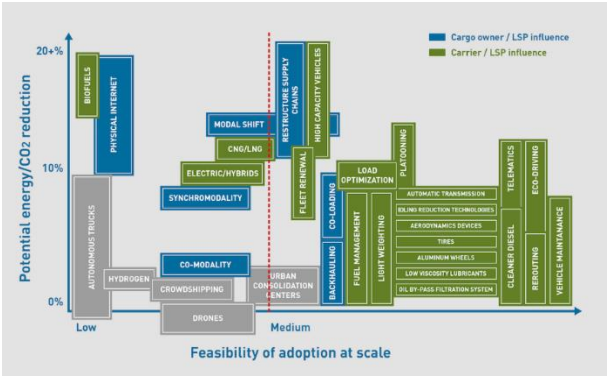
Road freight decarbonisation measures: *abatement – implementation graphs*



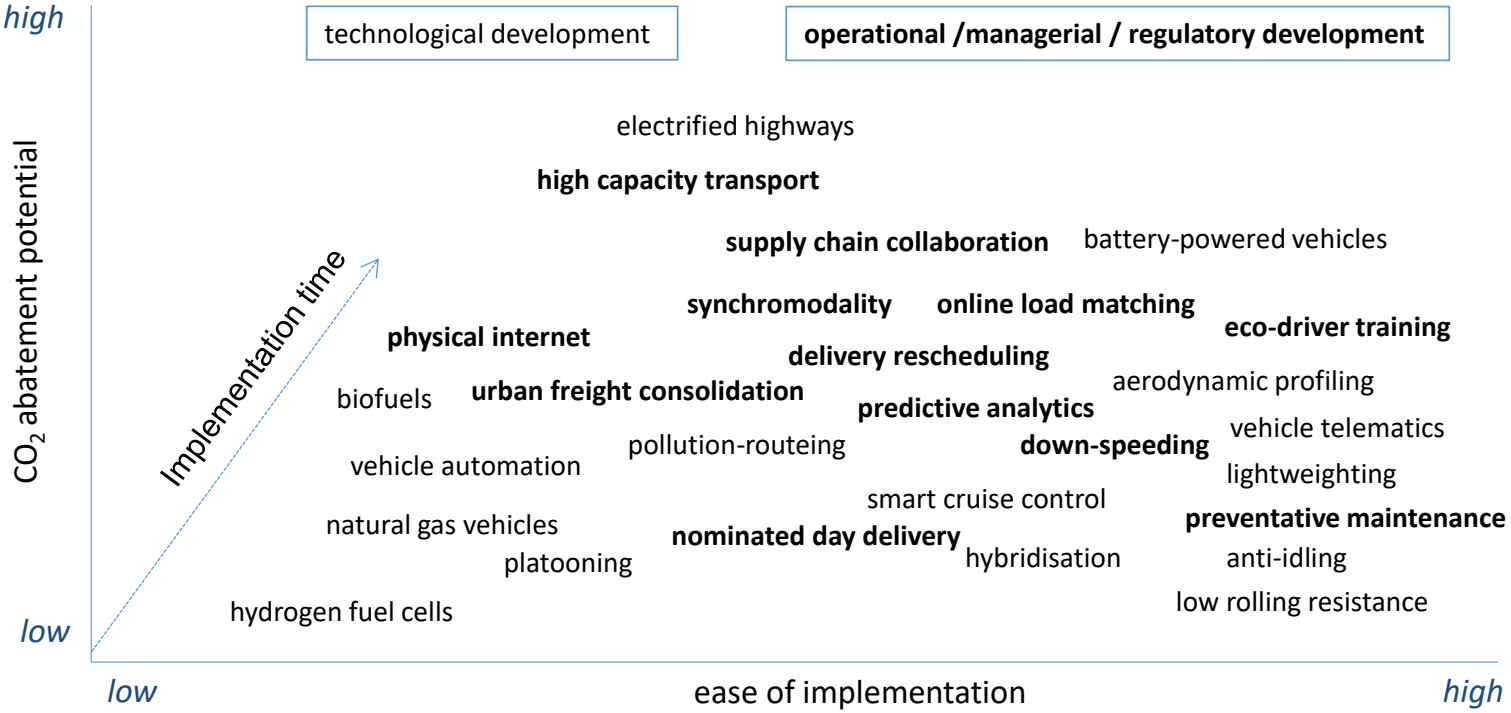
Professor Cebon



International Energy Agency



Smart Freight Centre



Source: McKinnon (2018) Decarbonizing Logistics

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Methods of Decarbonizing Freight Transport

reduce level of freight movement

- relocalize / decentralize
- circular and sharing economy
- digitisation
- 3D printing
- ‘pollution routing’ systems

shift freight to lower carbon modes

- synchromodality
- intermodal corridor strategies
- infrastructural enhancement
- internalise environmental cost

improve vehicle loading

- logistical collaboration
- relax JIT pressures
- online load matching
- liberalise high capacity transport
- consolidate urban deliveries

logistics

management

behaviour

regulation

increase energy efficiency

- energy-saving technologies
- fuel economy standards
- eco-driving: training / monitoring
- platooning / automation

switch to low carbon energy

- low carbon electrification
- switch to bio-fuels
- electrifying infrastructure
- refuelling / recharging networks

technology

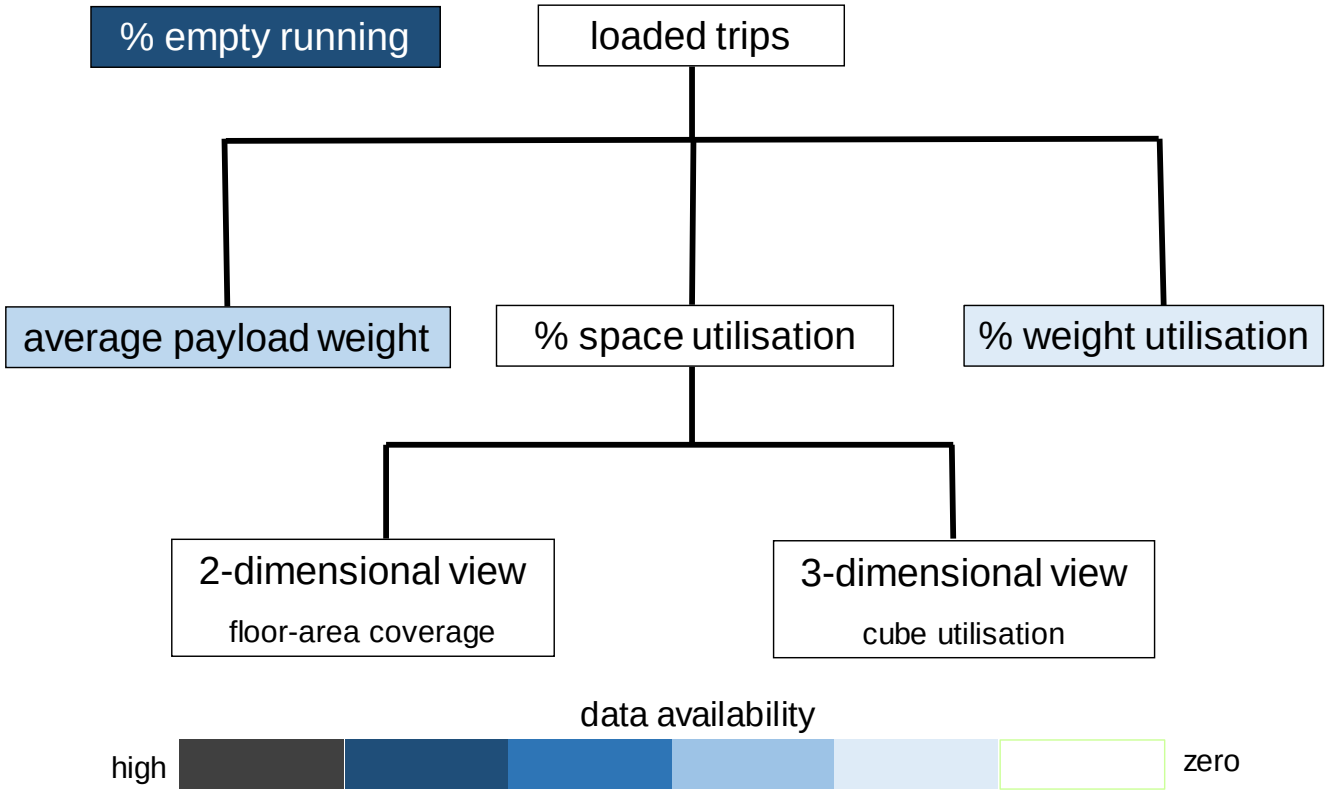
engineering

Under-estimation of the Logistical Contribution to Road Freight Decarbonisation

- disciplinary bias: *precedence of physical science / technology over social science!*

- difficult to quantify potential carbon savings from logistical options

  - lack of macro-level data: *especially on empty running and loading*
  - uncertainty about baseline conditions and rate of behavioural change



Macro-level Truck Utilisation Statistics: *available data in EU*

Under-estimation of the Logistical Contribution to Road Freight Decarbonisation

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- past experience discouraging:

empty running

% of EU truck kms run empty: *only declined from 25% to 23% between 2005 and 2015*

despite online load matching, relaxation of cabotage regulations, growth of reverse logistics

supply chain collaboration

much discussed and heavily promoted – *but still the exception rather than the rule*

Under-estimation of the Logistical Contribution to Road Freight Decarbonisation

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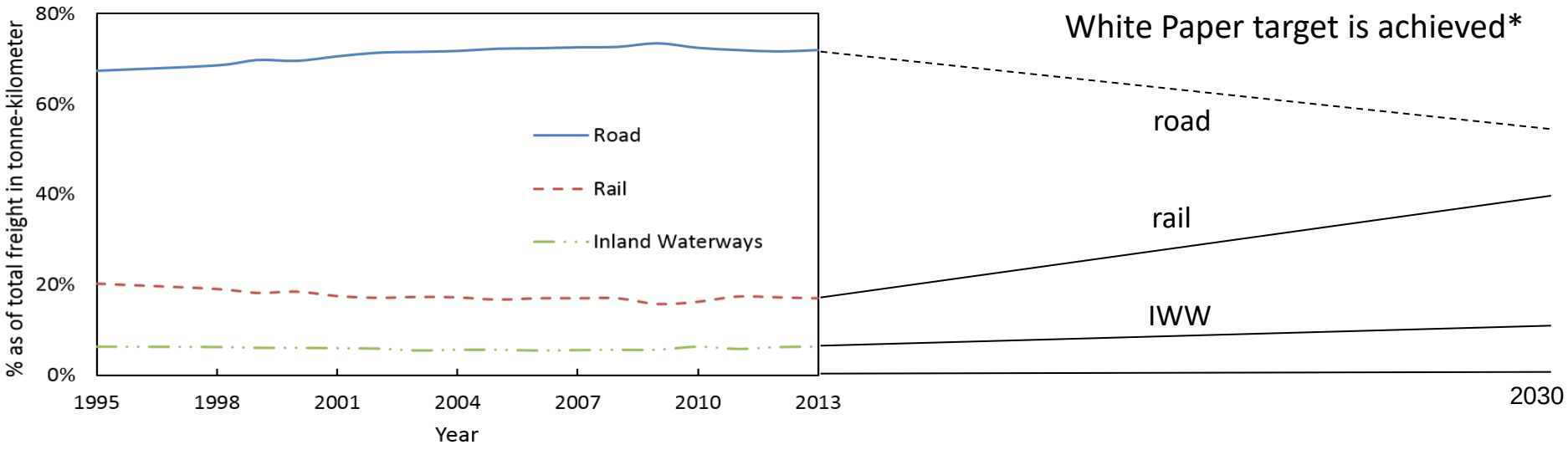
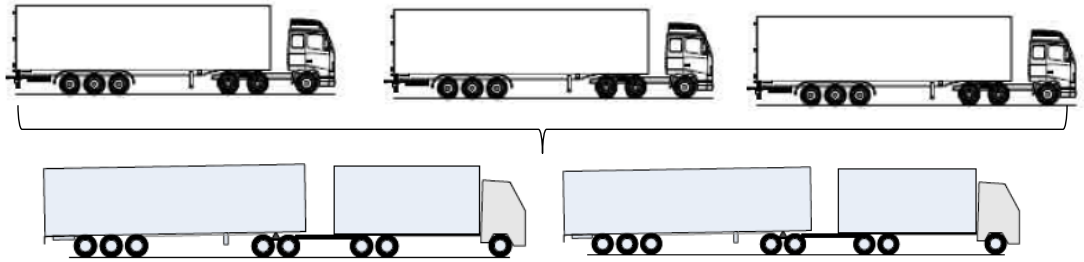
modal shift to rail and water

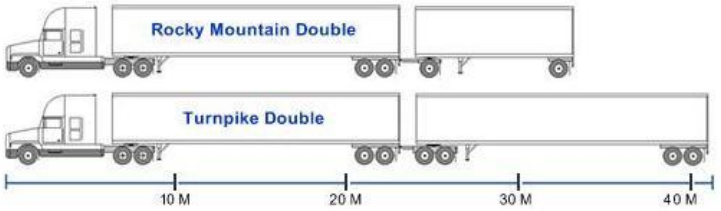
*based on analysis by Tavasszy and van Meijeren (2011)



- loss of fossil fuel tonne-kms from rail – will be difficult to replace
- rail may struggle to maintain current share
- narrowing carbon intensity gap between long haul road and rail freight

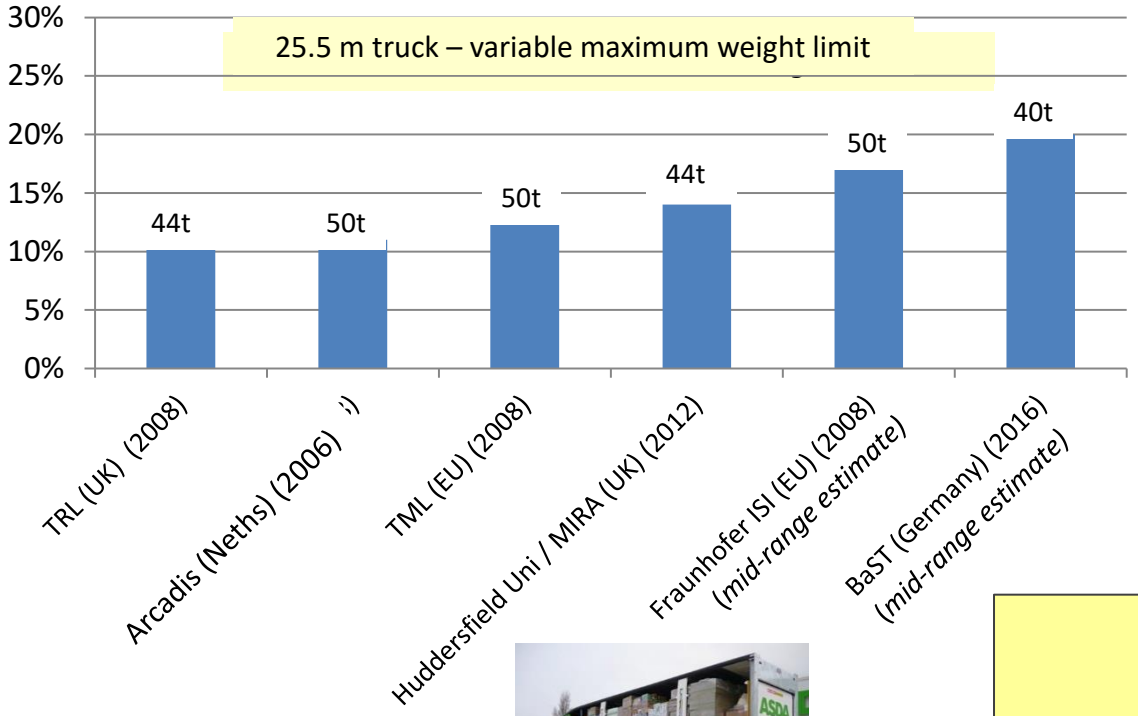
A regulatory quick win? Raise truck size and weight limits

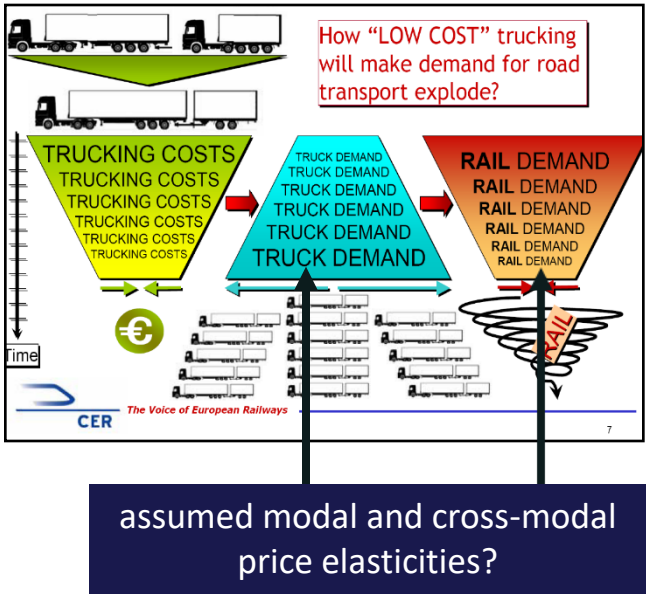




2 truck for 3 substitution: load consolidation → reduced energy use and emissions per tonne-km

% reduction in carbon intensity against baseline vehicle





assumed modal and cross-modal price elasticities?

freight modal shift
versus
road freight efficiency improvement

Conflict between freight decarbonisation strategies

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Uncertainties / Disagreements in Road Freight Decarbonisation Community

past energy efficiency improvements in new European trucks

Daimler	ICCT / T&E
15% improvement in fuel efficiency between 2003 and 2016	minimal improvement in fuel efficiency in 13 years to 2015

weight, size, recharging time and cost of HDV batteries

Sripad & Visvanathan, McKinsey etc	Tesla, ETC etc
10-12 tonnes for US Class 8 truck 400 kW per hour charging time	4-6 tonnes for US Class 8 truck 1600 kW per hour (Tesla)

practicality and cost-effectiveness of hydrogen fuel cells in HDVs

IDDRI, ETC etc	Bossel, Cebon et al
despite high energy losses, potentially viable decarbonisation option	energy losses so high never likely to be viable option

Anheuser-Busch to buy up to 800 Nikola hydrogen-electric trucks

Low-carbon electricity pathway	WTW energy efficiency	Euro cent per truck-km
Electrified road systems	77%	19
Battery	62%	20
Hydrogen	29%	55

Source: German Ministry of Environment

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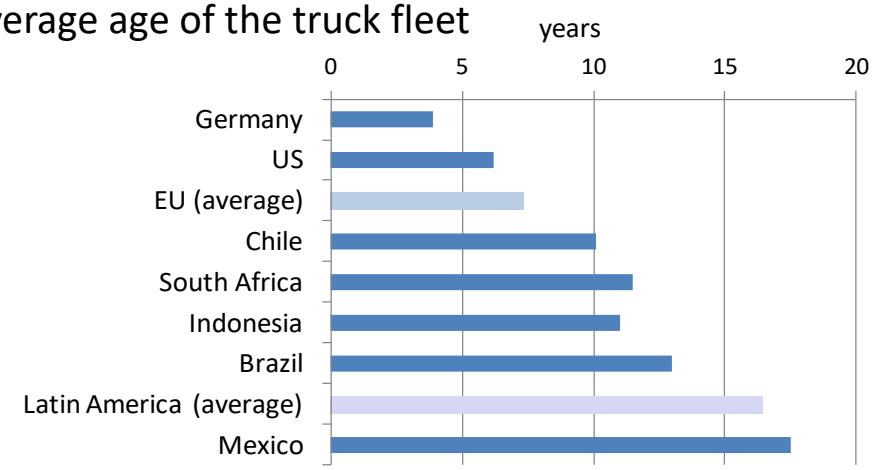
Transferability of Road Freight Decarbonisation Strategies

Developed country (OECD) bias in research, technology and strategy development

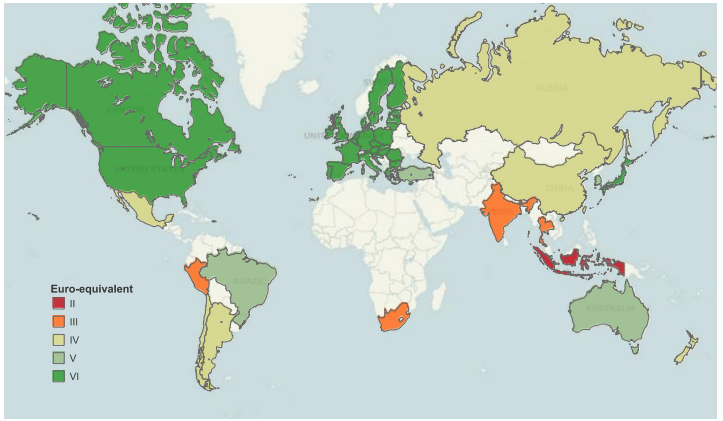
Much of the future growth of road freight in emerging markets

Relatively slow diffusion of truck technology to developing countries

average age of the truck fleet



emission standards for new trucks



Deficiencies in global market for second-hand trucks

In many emerging markets carbon intensity of electricity is high and only slowly declining

Limited resources for investment in highway electrification and recharging facilities

Need different road freight decarbonisation strategies and pathways for less developed countries?

Professor Alan McKinnon

Kühne Logistics University – the KLU
Wissenschaftliche Hochschule für Logistik und Unternehmensführung
Grosser Grasbrook 17
20457 Hamburg

tel.: +49 40 328707-271
fax: +49 40 328707-109

e-mail: Alan.McKinnon@the-klu.org
website: www.the-klu.org
www.alanmckinnon.co.uk

@alancmckinnon