Transparency systems for transport

Methodologies and approaches

www.**ricardo**.com

Guidance and support

Top-down vs bottom-up
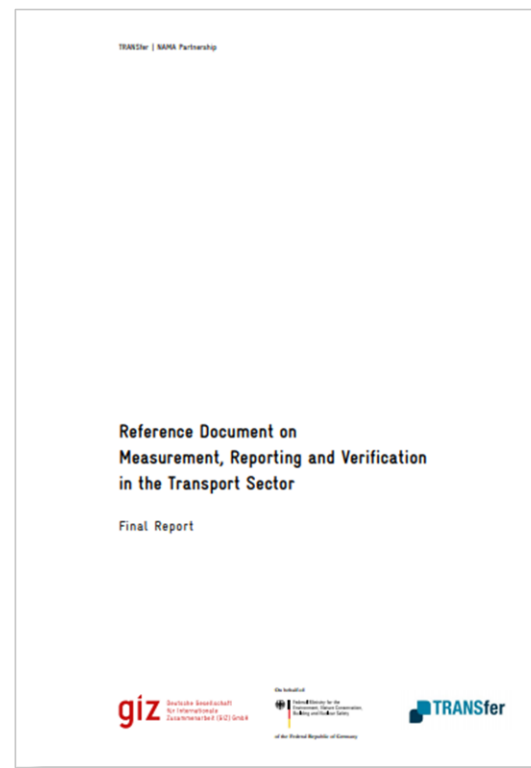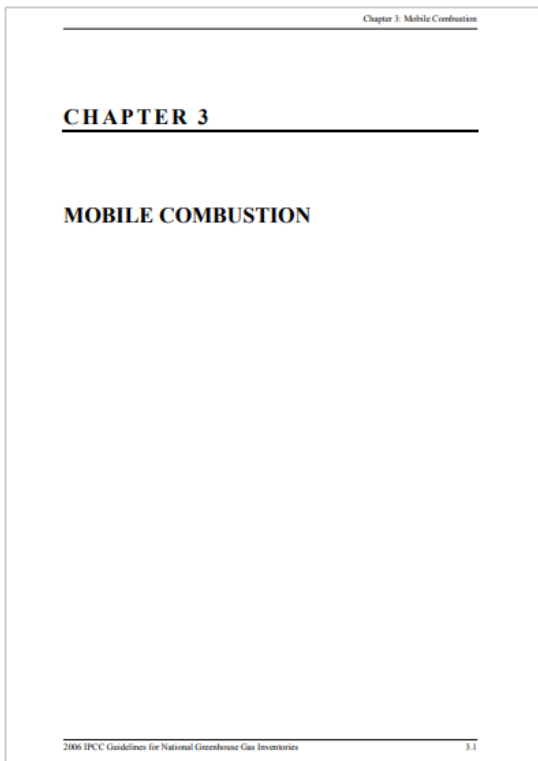
Top-down

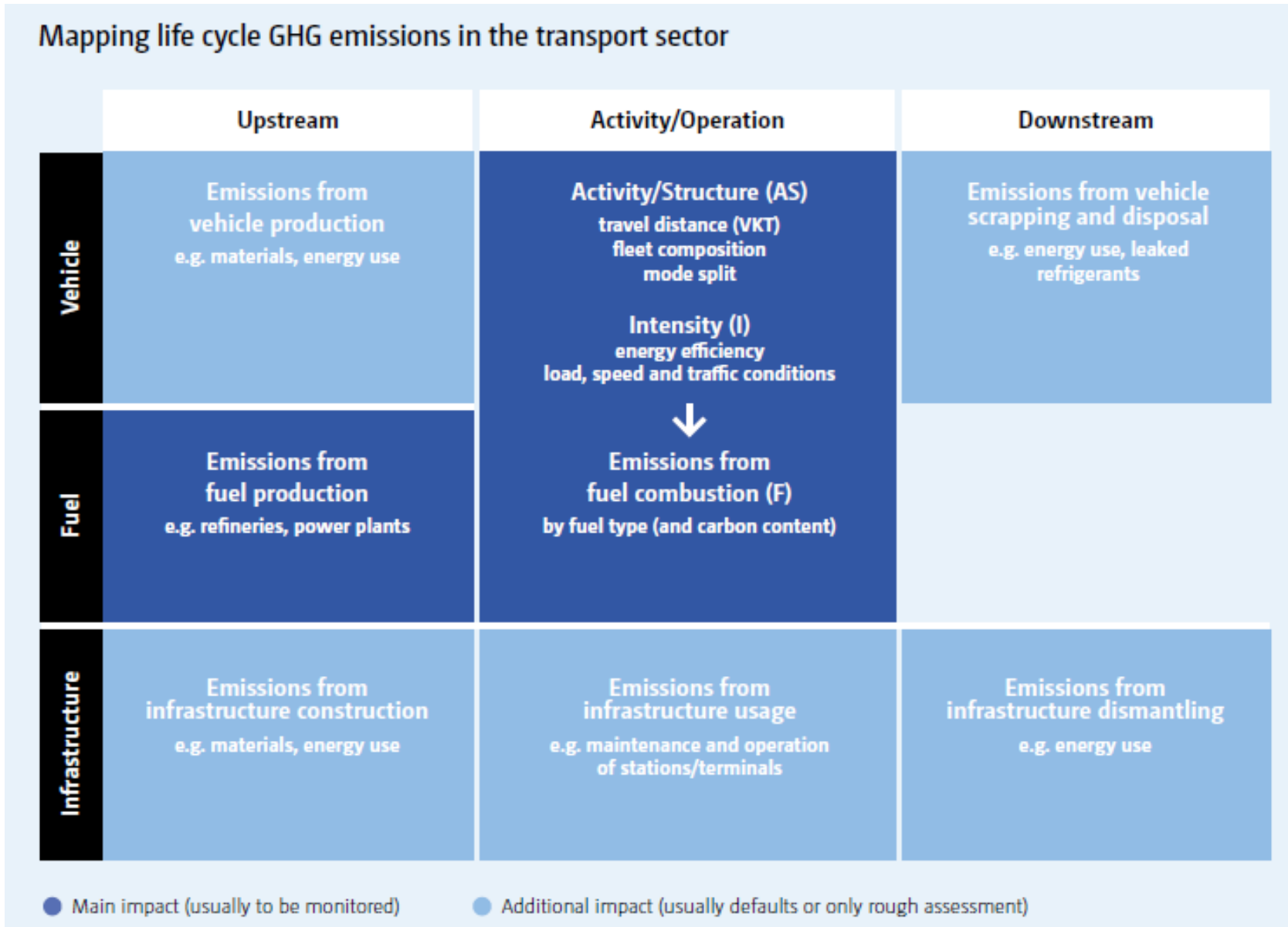- Total GHG = Total fuel volume * GHG/unit volume = Advantages:
  - Simple
  - Allows for comparison between countries
- Disadvantages:
  - Diverse use of fuel
  - Cross-border dales / fuel smuggling
  - Limited information value
  - Coverage (e.g. doesn't include EVs)
  - Applicability to GHGs

Bottom-up

- Total GHG = A * S * I * F
  - A = activity or avoid = demand for transport
  - S = structure or shift = what modes people are using
  - I = Improve or fuel intensity = efficiency
  - F = fuel = emissions per unit of fuel
- Can be rough or detailed calculation
  - Rough = high uncertainties
  - Detailed = time and resource intensive

Lifecycle emissions

Mapping life cycle GHG emissions in the transport sector

	Upstream	Activity/Operation	Downstream
Vehicle	Emissions from vehicle production e.g. materials, energy use	**Activity/Structure (AS)** travel distance (VKT) fleet composition mode split **Intensity (I)** energy efficiency load, speed and traffic conditions ↓ **Emissions from fuel combustion (F)** by fuel type (and carbon content)	Emissions from vehicle scrapping and disposal e.g. energy use, leaked refrigerants
Fuel	Emissions from fuel production e.g. refineries, power plants		
Infrastructure	Emissions from infrastructure construction e.g. materials, energy use	Emissions from infrastructure usage e.g. maintenance and operation of stations/terminals	Emissions from infrastructure dismantling e.g. energy use

● Main impact (usually to be monitored)   ● Additional impact (usually defaults or only rough assessment)

Transport indicators

- Number of vehicles
- Number of trips
- Distances travelled
- Occupancy (or loading) of vehicles

- Vehicle km (VKT)
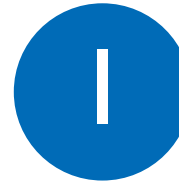- Passenger km (pkm)
- Ton kilometer (tkm)

A + **S** + **I** + **F** → **GHG**

- Occupancy
- Driving behaviour
- Engine technology
- Weight
- Aerodynamic design
- Rolling resistance of tyres and congestion on the road

Energy units per unit of activity, e.g. litres of fuel per vehicle kilometre (or pkm) or kWh per tkm

Conversion factor of the fuel (the amount of GHGs released per unit of energy consumed (grams of carbon per litre of fuel consumed)

Indicators

	Category of data	General Indicators	Options for further differentiation
Top-down — Energy use	Fuels sold / consumed	• Amount of various fuels sold/used (in litre or MJ)	• by region • by vehicle types/classes
Top-down — Emission Factors for fuels (F)	Carbon content	• Net Calorific Value of fuel (kgCO$_2$/MJ) for each fuel type ▶ Grid emission factors for electricity	• Correction factors for indirect emissions (based on lifecycle assessment) • Fuel quality e.g. sulphur content
Bottom-up — Activity (A) and Modal Shift (S)	Fleet composition	• Number of vehicles by vehicle type (car, truck, motorcycle etc.)	• by vehicle classes / engine size • by vehicle age / technology
	Distances travelled	• Vehicle kilometre by vehicle type (in VKT) • Passenger kilometre (pkm) • Ton kilometre (tkm)	• by mode • by vehicle classes / engine size • by vehicle age / technology
	Trips	• Number of trips • Tons transported • Trip length	• by mode • by trip purposes (e.g. work, leisure etc.)
	Load factor	• Occupancy (in persons/vehicle) • Load of goods vehicles (in percent)	• by mode • by vehicle classes / engine size
Bottom-up — Intensity (I)	Fuel consumption	• fuel consumption (in litre or kwh/km) by vehicle type	• by vehicle classes (size usually related to weight) • by vehicle age engine technology (e.g. Euro standards) • Speed and/or congestion on the road (level of service) • By load (for trucks) • By gradient (for trucks) • Aerodynamic design and rolling resistance of tires
Further useful statistics (e.g. used as normalising factors)	Population	• Number of inhabitants • (Average) household size	• by urban vs. rural • Working population • by age • with driver licence
	Economic development	• GDP (or GDP per capita) • (Household) income	• by (sub-)sector
	Network	• Length or roads, rails etc.	• by road type

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Other indicators – example of the UK Committee on Climate Change

Table 5.3 The Committee's transport indicators					
ROAD TRANSPORT		Budget 2	Budget 3	Budget 4	2013 outturn
Headline indicators					
Emissions (% change on 2007)	Road Transport	-24%	-36%	-46%	-11.4% (2012)
Vehicle km (billion)	Car	413	428	452	406
	Van	76	84	93	72
	HGV	26	27	27	26
Supporting indicators					
Vehicle technology					
New vehicle gCO$_2$/km	Car	111	95 (by 2020)	57	128.3
	Van	164	147 (by 2020)	89	186.1
New electric vehicles (cars and vans) registered each year		35,000	525,000	1,470,000	3,584
Stock of electric vehicles (cars and vans) in fleet		75,000	1,340,000	6,645,000	7,442*
Review of financial mechanisms for addressing up-front costs to EVs		2017			
Roll-out of strategic rapid charging network			2020		
Strategy for development of residential off-street charging points		2015			
Action plan for engaging local authorities in providing measures to support EV uptake		2015			
Full evaluation of GHG implications of methane trucks		2015			
Biofuels					
Penetration of biofuels (by energy)		5.9%	8.4%	9.9%	2.9%
Develop trajectory for RTFO to meet EU 2020 target following EU agreement		2015/16			
Demand side measures					
Evaluate effectiveness of LSTF and commit to further funding if appropriate		2016			
Nationwide rollout of Smarter Choices if appropriate			Complete		LSTF funding Smarter Choices projects in 77 Local Authorities in England
Review effectiveness of voluntary industry approach to reduce emissions in freight sector		2016			

Other indicators – example of the UK Committee on Climate Change (continued)

Table 5.3 The Committee's transport indicators

Other drivers
Contextual
GDP and manufacturing output
Population
Car ownership
Cost of car travel vs. cost public transport
Trends
Petrol/diesel consumption
Modal split
New vehicle CO_2
New car sales that are best in class
Proportion of s/m/l cars
EU targets for new HGV CO_2
Post-2020 EU targets for new car and van CO_2
ULEVs
EV and H2 vehicle models on market
Battery costs
Biofuels
EU agreement on how to meet the 10% biofuel target
Demand side
Funding allocated to and population covered by Smarter Choices
Proportion of drivers exceeding 70mph
HGVs
gCO_2/tonne km
Uptake of freight logistics improvement measures (e.g. fleet management software, eco-driving)

Other indicators – example of the UK Committee on Climate Change (continued)

Table 5.1: Progress to date against indicators in transport: traffic light assessment

Indicator	Traffic Light	Comments
New car CO_2	Green	Outperforming our indicator trajectory. Evidence of a growing gap between real world and test cycle emissions suggest real world improvements were smaller; however likely still to have met trajectory.
Fleet average gCO_2/v-km – vans	Amber	Emissions intensity of van travel is better than our indicator in absolute terms as data issues meant our indicator was overestimated; however the rate of reduction has been less than expected
Fleet average gCO_2v-/km – HGVs	Amber	Not meeting indicator trajectory: emissions intensity actually rose. However this may be due to a move to larger trucks which could reduce vehicle km. Data quality is an issue.
EV car sales	Red	Uptake well below our indicatory trajectory, although market developments (e.g. availability of a range of models) have been positive, and in hindsight uptake in the proposed trajectory was too high over the first carbon budget period.
Biofuel policy	Amber	Biofuel penetration was in line with our trajectory to 2011; it has fallen short of our indicator in the past two years but with improvements in sustainability.
Smarter Choices policy	Amber	The Local Sustainable Travel Fund is funding a number of projects across England; however the framework for evaluating carbon savings is not comprehensive
Eco-driving training	Red	While there has been good progress in the freight sector, uptake of training by car and van drivers is well short of indicator trajectory with no concerted effort to promote address this.

Figure 5.2: Breakdown of surface transport CO_2 emissions by mode (2012)

Motorbikes and other 1%
Rail (direct) 2%
HGVs 22%

Total emissions 110 MtCO₂

Source: NAEI (201
Notes: 'Other' inc

Figure 5.19: Average annual costs to consumers of EVs vs conventional cars

- Annual fuel costs
- Annual capex

Period: 5 years, DR: 7.5%   Period: Vehicle lifetime, DR: 3.5%

Source: CCC estimates based on modelling by Element Energy and Ricardo-AEA.
Notes: 'Period' is period over which battery costs are annuitised; 'DR' is discount rate used for battery. In all cases, the remaining vehicle cost is annuitised of the vehicle using a discount rate of 7.5%. Estimates are for a medium car.

Figure 5.

GDP   Manufacturing output   Population   Real Brent oil price

Source: CCC calculations based on Office of National Statistics and IEA Data.
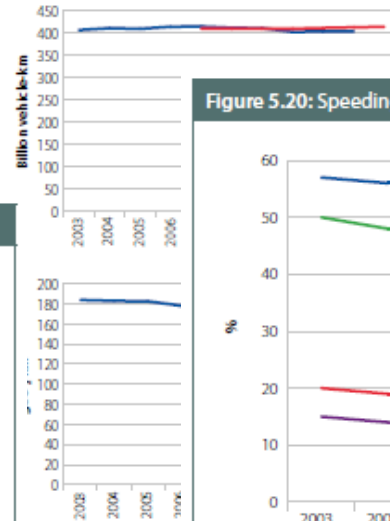

ce: NAEI (2013), DfT (2013

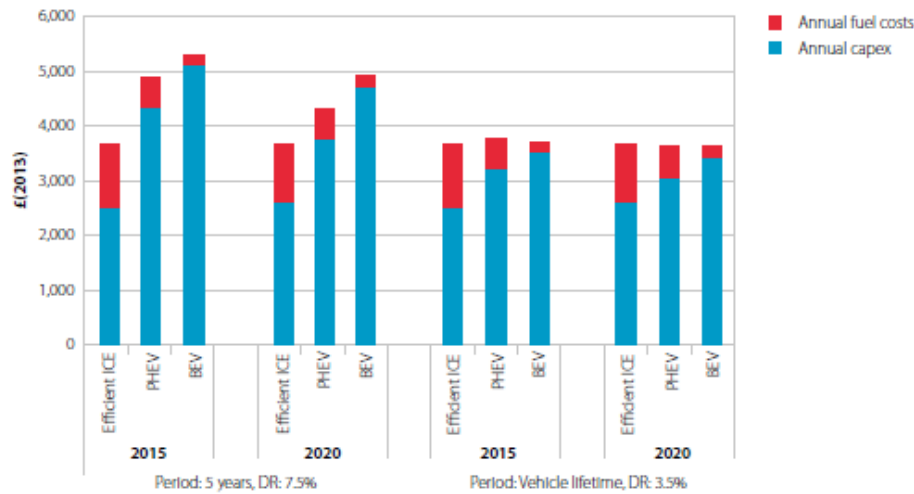**Figure 5.20:** Speeding rates on motorways and dual carriageways (2003-2012)

- Motorways (% exceeding limit)
- Motorways (% exceeding limit by >10mph)
- Dual carriageways (% exceeding limit)
- Dual carriageways (% exceeding limit by >10mph)
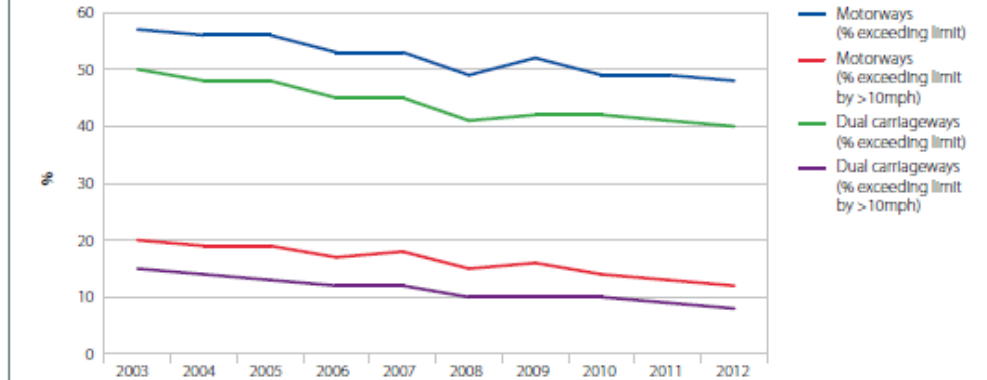
Source: DfT Free flow vehicle speed statistics.

Figure 5.21: Use of technology measures in freight logistics (2004-2010)

- GPS
- Computer
- Fleet management software
- Double deck trailers
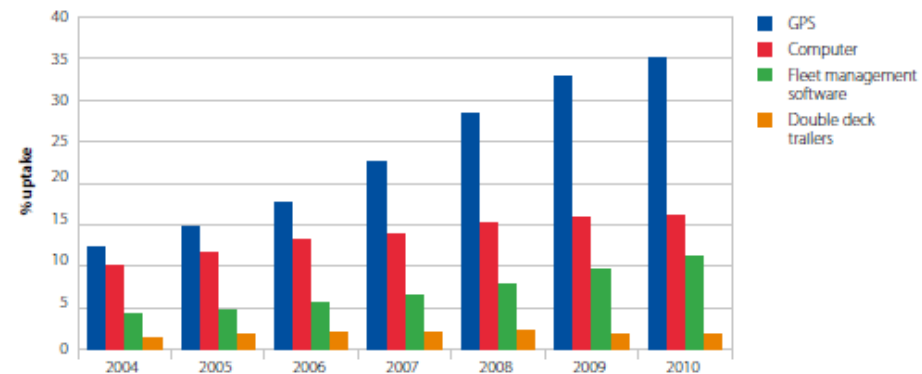
Source: (DfT) Continuing survey of road goods transport.

Source: SMMT (2014).

Data collection

- Can be used direct (e.g. numbers of vehicle registrations) or indirect (e.g. accident data helping estimation of occupancy levels).

- Ideal case – systematic reporting using regular reporting from target groups.

- Surveys – in person, telephone, mail, online, combination.

- Observations, e.g. traffic counts. Usually used for traffic characteristics, e.g. occupancy, speed etc.
  - Can be through video, ANPR etc. Can then link to registration databases.

- Technologies, e.g. GPS. Can be used for triangulation.

- Dynamometer-based tests or PEMS.

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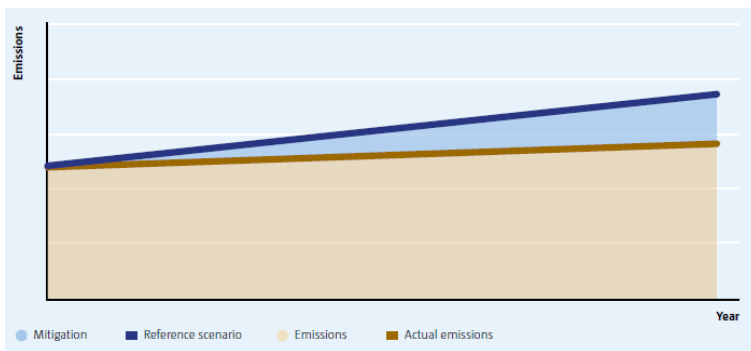Table 5: Summary of Japanese transport data collection (Source: MLIT)

Mode	Vehicles	Activity	Fuel Use	Data Collection Method
Cars	Number of cars by fuel type: private conventional cars, taxis, mini cars	Km/car by fuel and type; passenger km by car type	Fuel use/km by fuel and car type	Random sampling; Survey method: enumerator survey (partially by mail)
Buses	Transit Buses; intercity buses	Vehicle kilometres and passenger-kilometres	Fuel use by type	
Rail	Intercity Rail; urban and commuter rail	Freight by type; cargo transport volume by operational mode and by vehicle type (trans-port tonnage/tons-km), pas-senger transport volume by operational mode and by vehicle type (number of passen-gers/passengers-km), transport frequency, and distance	Fuel con-sumption	Survey of passenger traffic receipt; survey of freight volume
Domestic Air	Number of units handled for transport and operating hours of air-craft.	Weight; capacity; num-ber of passengers; num-ber of passengers trans-ported; weight of pas-sengers transported; number of flight ser-vices; cargo weight; utilization of capacity; transport ton-kilometres	Fuel con-sumption	Complete enumera-tion using survey method by mail or on-line application (self-entry)
Domestic Maritime – coastal, ferries, rivers	Number and gross tonnage of incoming vessels	Passenger km Number of passengers, marine incoming and outgoing freight; land incoming and outgoing freight	Fuel Use/ passenger km	Survey on Ports and Harbour; Land In-coming and Out-going Freight Survey by using enumerator survey (self-entry)

Institutions

Institution	Level	Responsibilities	Type of data
Data consumption			
Legislative body	National / provincial	Provision of the legal basis for data collection and reporting requirements for operating entities; transport-related legislation	
Ministry of Transport / Infrastructure	National / provincial	Spatial planning; investment in national infrastructure; regulation of public and private transport; initiating transport-related legislation and data requirements	
Local administrations	Municipal / city	Spatial planning; investment in local infrastructure; regulation of local public transport	
Data aggregation and analysis			
Institutionalised data			
Statistics Office(s)	National / provincial	Gathering and aggregation of data at national or provincial level	Aggregated statistical data at national/provincial but also local/city level
Various Ministries	National / provincial	Gathering and aggregation of data at national or provincial level	Various data collected for non-transport planning purposes, e.g. related to taxes, working conditions, commerce, energy use, etc.
Transport Authorities	National / provincial / local (mode specific)	Regulation, planning and research on specific transport related areas, usually specialised, e.g. road transport, rail infrastructure, vehicle registration, etc.	Mode specific data: vehicle registration; freight data; passengers transported; transport infrastructure
Project oriented data			
Environmental Protection Agency	National/provincial	Research on environmental aspects of transport, e.g. air pollution, noise emissions	Safety, air pollution, other non-GHG environmental impacts
Universities / Research Institutes / Consultancies	International / national / provincial / local	Development of methodologies and tools, data collection through surveys	Household mobility patterns, preferences
Industry associations	National	Data collection and aggregation from members	Technical data on vehicle performance, expected trends, industry specific data
Original data sources			
Railway operator(s)	National / provincial / local	Delivery of data based on legal requirements or voluntary	Infrastructure, passengers carried, freight carried, cost/prices
Public transport operator(s)	Provincial / local		Infrastructure, passengers carried, cost/prices
Freight operators	National / provincial / local		Freight carried, cost/prices
Vehicle manufacturers	National		Vehicle sales, technical specifications
Energy companies	National / provincial / local		Fuel sales
Households		Voluntary delivery of data	Mobility patterns, cost/prices

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Measuring policy impacts

- WRI policy and action standard
- Causal chain
- Boundary setting
- Leakage and rebound effects
- BAU setting
  - Travel demand modelling
  - Historical trends
  - Control group methods
  - Default or proxy data
  - Survey questions
  - Expert opinion

Installation of Bus Rapid Transport system				
	Direct effect	Indirect effect	Likelyhood/Impact	MRV parameters
A	N.A.	Positive - Reduced travel time - Reduction in GHG emissions and air pollution - Reduced health impacts	Positive effects likely and of major relevance	Number of trips conducted in BRT Time gained
S	Increased share of passenger trips in public transport	Negative - Construction emissions - Increased emissions from congestion in car lanes	Negative effects likely and of moderate relevance	Shares of travel by mode Congestion frequency Respiratory disease statistics BRT Bus Emission Factors
I	Reduced fuel efficiency due to increased congestion during construction phase Improved fuel efficiency from better traffic flow during operational phase	N.A.	Effects likely and of minor relevance	Fuels consumption per km
F	N.A.	N.A.	N.A.	N.A.

Legend: Mitigation · Reference scenario · Emissions · Actual emissions
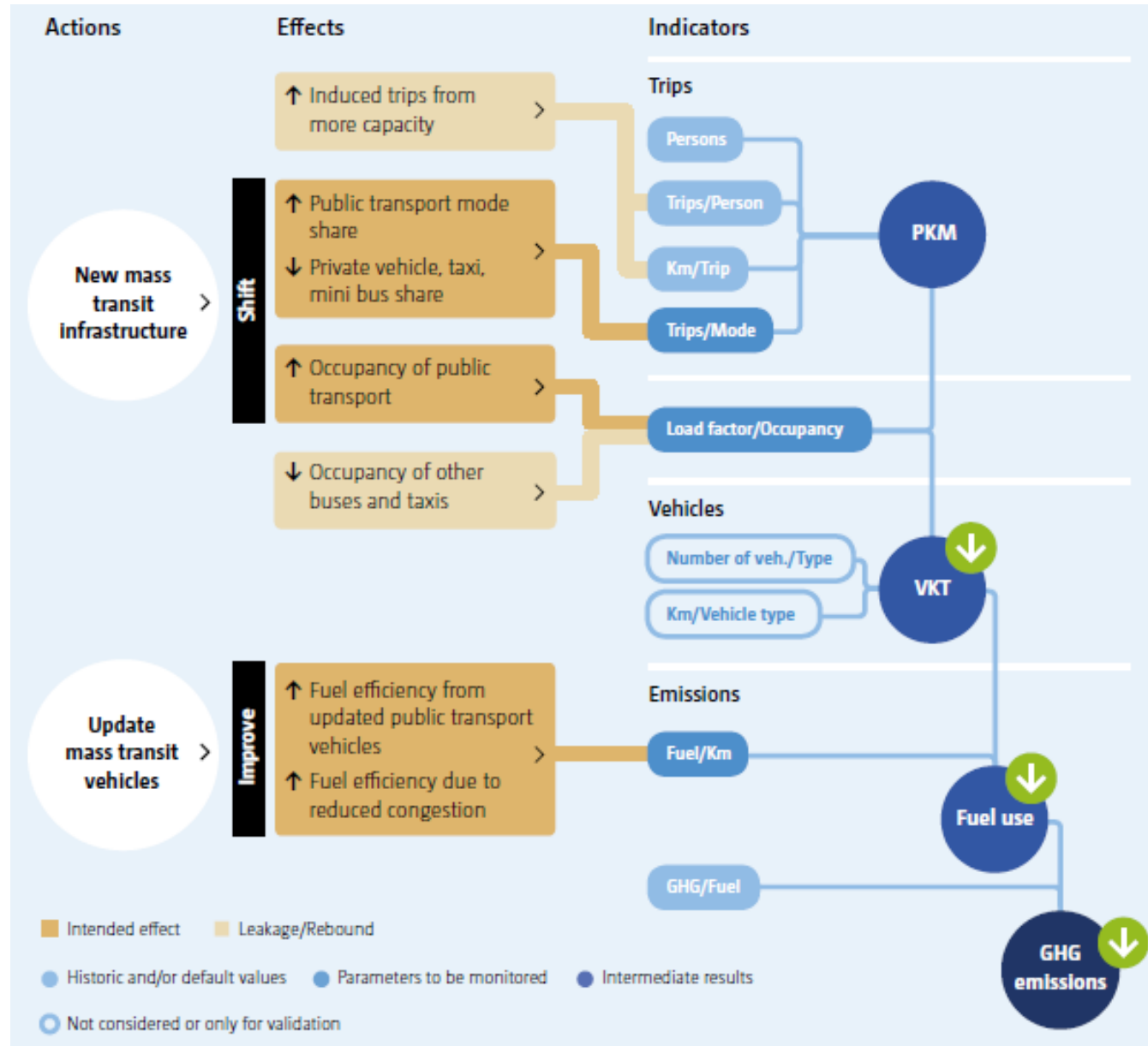
Compendium on GHG baselines and monitoring

A section for each key mitigation action type

- Mass transit initiatives

- Comprehensive urban transport programmes and plans

- Vehicle efficiency improvement programmes

- Alternative fuels incentives, regulation and production

- Inter-urban rail infrastructure

- Modal shift from road to rail and water

- National fuel economy standard

- Pricing policies

A common format for each section

- Structure of mitigation effects
  - Cause-impact chain
  - Key variables to be monitored
  - Interaction factors
  - Boundary setting
  - Key methodological issues
  - Double counting concerns

- Determining the baseline and calculating emission reductions
  - Analysis approach
  - Uncertainties and sensitivity analysis

- Guidance on the selection of analysis tools for the mitigation action type
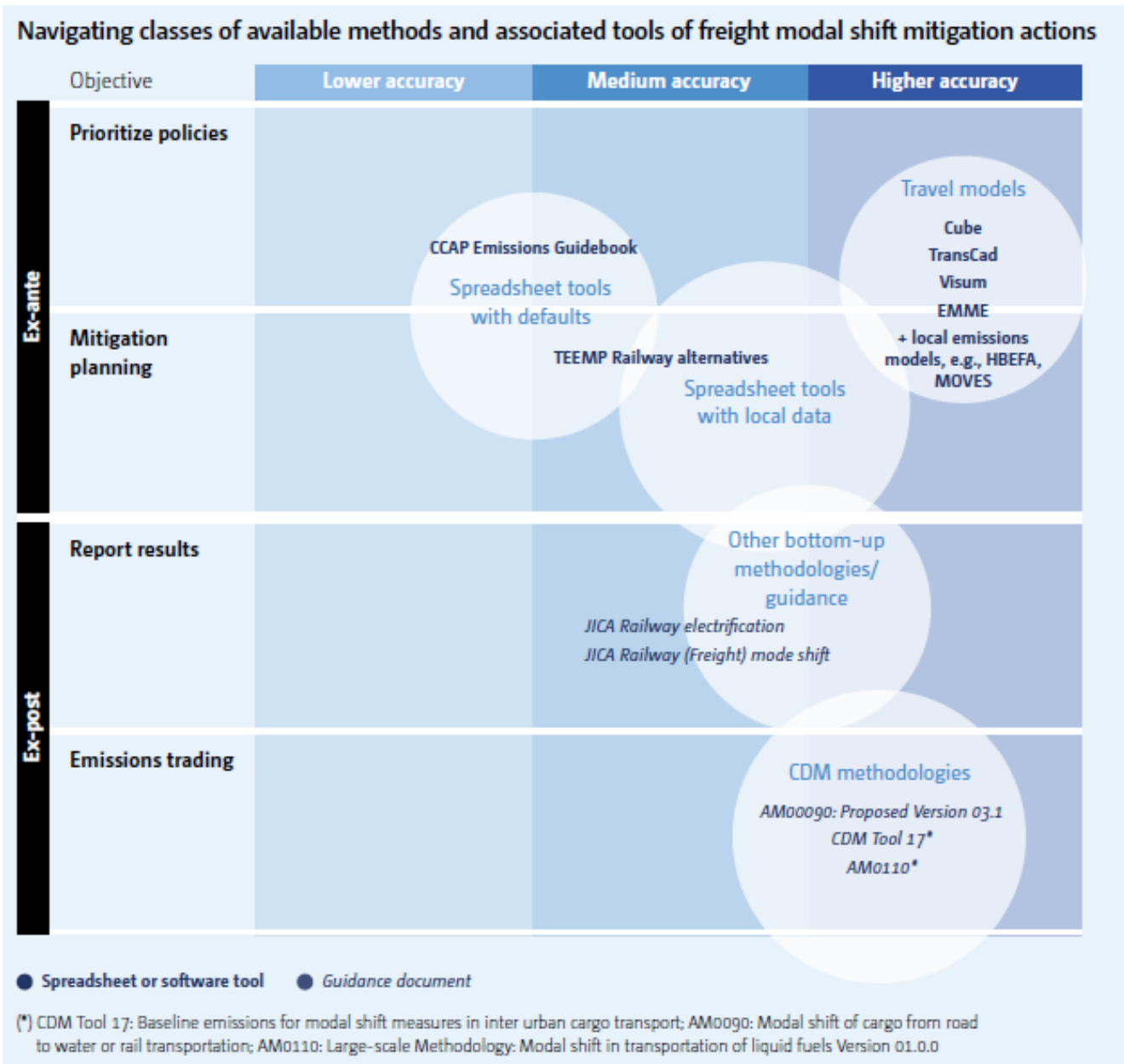
- Monitoring

- Example

Cause-impact chain for mass transit

Guidance on data for fuel economy improvement programmes

	Degree of local data disaggregation and context variables		
	Lower accuracy	**Medium accuracy**	**Higher accuracy**
Fuel sales data	• Current volume of transportation fuels sold in country, by fuel type • Forecast-year volume of transportation fuels sold in country, by fuel type	• Current volume • Forecast- year volume • Projected fuel cost differential versus conventional fuel after incentive, and net change in vehicle operating cost for consumer	• Current volume • Forecast- year volume • Total volume of fuels sold within broader region, by fuel type (to examine diversion effects) • Analysis of whether alternative fuel demand would be new, or diverted from other existing uses • Maximum value of available alternative fuels
Vehicle and infrastructure data		• Fraction of existing vehicle fleet capable of using alternative fuel(s) targeted by policy • Extent to which renewable/low-GHG fuel infrastructure is deployed and fuel available	• Projected change in vehicle purchase price (for dedicated-fuel vehicles) and payback period given projected fuel prices • Differences in key performance attributes for alternative fuel versus conventional fuel vehicles (e.g., range, cargo capacity, safety)
Emission factors	• Default emission factors for fuel types	• Life-cycle emissions associated with unit of fuel, by type	• Actual life-cycle emissions considering production pathways used

Guidance on analysis tools for modal shift

Navigating classes of available methods and associated tools of freight modal shift mitigation actions

(*) CDM Tool 17: Baseline emissions for modal shift measures in inter urban cargo transport; AM0090: Modal shift of cargo from road to water or rail transportation; AM0110: Large-scale Methodology: Modal shift in transportation of liquid fuels Version 01.0.0

Any questions?