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Sustainable Energy Connectivity in Central Asia

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Presentation on data collection methods and complilation of the energy statistics: TRANSPORT

Training Course on Energy Statistics
11-13 July 2023, Tashkent, Uzbekistan

Stantec | intec | ACTED | European University Institute | Robert Schuman Centre for Advanced Studies | FSR Energy | Florence School of Regulation

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Data collection and compilation, examples of questionnaires, examples of the results

MAIN STATISTICS ON TRANSPORT SECTOR

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Final consumption transport in Kazakhstan in 2019

Data sources for aggregated and intermediate indicators is energy balance

Kazakhstan

Terajoules

	Primary coal and peat	Coal and peat products	Primary Oil	Oil Products	Natural Gas	Biofuels and waste	Nuclear	Electricity	Heat	Total energy	of which: renewables
Final consumption	340531	46340	63	483257	211605	3179	..	259039	229052	1573067	3179
Final energy consumption	340531	46340	63	440227	201037	3179	..	259039	229052	1519468	3179
Manufacturing, const., mining	138178	46340	..	62806	47588	..	..	158690	86692	540294	..
Iron and steel	23101	32921	..	19937	1413	..	..	51055	26987	155415	..
Chemical and petrochemical	533	9110	..	873	15461	..	..	12702	4929	43608	..
Non-ferrous metals	66316	3039	..	3400	..	..	..	51233	618	124606	..
Non-metallic minerals	27402	253	..	3189	5402	..	..	5950	1657	43853	..
Transport equipment	45	41	..	227	364	..	..	176	33	886	..
Machinery	1280	..	..	1203	617	..	..	2317	1661	7077	..
Mining and quarrying	17019	975	..	18628	11775	..	..	23607	20091	92095	..
Food and tobacco	1323	..	..	2641	9703	..	..	5893	4966	24525	..
Paper, pulp and printing	23	..	..	181	743	..	..	398	536	1882	..
Wood and wood products	29	..	..	52	11	..	..	37	46	174	..
Textile and leather	101	..	..	80	321	..	..	491	109	1102	..
Construction	1006	..	..	12397	1780	..	..	4830	8059	28072	..
Industries n.e.s	0	0	..	0	0	..	..	0	17000	17000	..
Transport	525	..	63	230246	5437	..	..	12690	..	248961	..
Road	..	..	..	224410	5437	..	..	..	..	229847	..
Rail	525	..	..	..	..	..	..	12690	..	13215	..
Domestic aviation	..	..	..	5677	..	..	..	..	..	5677	..
Domestic navigation	..	..	..	159	..	..	..	..	..	159	..
Pipeline transport	..	..	63	..	..	..	..	..	..	63	..
Transport, n.e.s	..	..	..	..	..	..	..	..	..	..	..
Other	201828	..	..	147176	148011	3179	..	87659	142360	730213	3179
Agriculture, forestry, fishing	3897	..	..	15218	2291	..	..	3049	6138	30592	..
Commerce, public services	30173	..	..	21547	25386	..	..	28871	89510	195488	..
Households	167477	..	..	109715	120335	1481	..	55739	46712	501459	1481
Other consumers	281	..	..	696	..	1697	..	..	..	2675	1697
Non-energy use	..	..	..	*43030	10569	..	..	..	..	*53598	..

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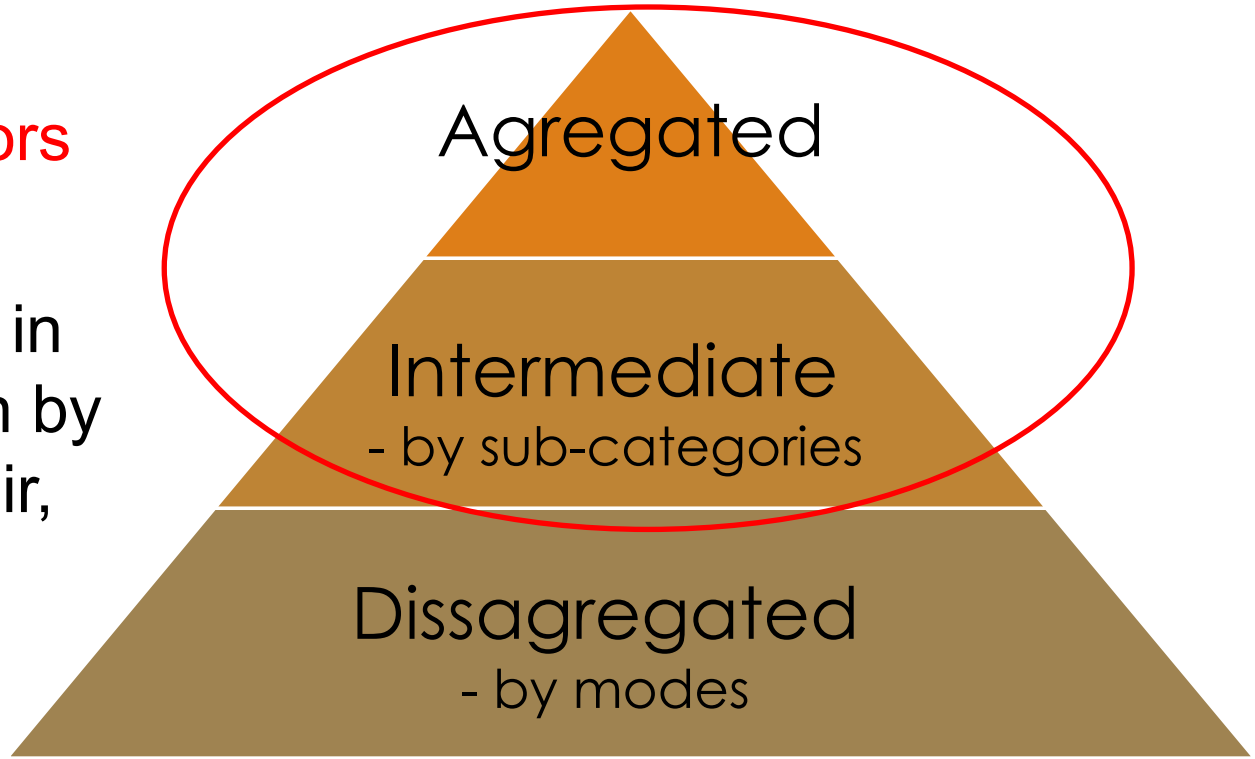
Structure of the indicators in transport sector

Aggregated and intermediate indicators

Data source: Energy balance

Indicators: Total energy consumption in transport sector, Energy consumption by transport sub-categories (rail, road, air, naval) and structure of consumption



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ANNUAL QUESTIONNAIRE ON ENERGY CONSUMPTION FOR RAIL TRANSPORTATION

Table 1. Purchase and consumption of electricity, fuel and lubricants

		Unit	Total
1.	**Purchase:**		
1.1.	- gas diesel oil	t	
1.2.	- fuel oil: low sulphur content	t	
1.3.	- fuel oil: high sulphur content	t	
1.4.	- lubricants	t	
2.	**Consumption:**		
2.1.	- electricity	MWh	
2.2.	- gas diesel oil	t	
2.3.	- fuel oil: low sulphur content	t	
2.4.	- fuel oil: high sulphur content	t	
2.5.	- lubricants	t	

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Table 2. Purchase and consumption of fuel and lubricants					
		Aviation gasoline	**Gasoline Type Jet Fuel**	**Kerosene Type Jet Fuel**	**Lubricants**
		t	t	t	t
1	**Purchase (1+2)**				
1.1.	In the country				
1.2	Abroad				
2.	**Consumption (4+5+6+7)**				
2.1.	International aviation				
2.2.	Domestic aviation				
2.3.	Education and trainings				
2.4.	Other				

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Benchmarking/comparisons between countries

ANNUAL QUESTIONNAIRE ON ENERGY CONSUMPTION FOR TRANSPORT IN INLAN

Table 3. Purchase and consumption of fuel and lubricants

		Transport diesel	Marine diesel (heating gas oil)	Res. fuel: Low sulphur content	Res. fuel: High sulphur content	Lubricants
		t	t	t	t	t
1	**Purchase (1.1+1.2)**					
1.1.	In the country					
1.2	Abroad					
2.	**Consumption**					

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ANNUAL QUESTIONNAIRE ON ENERGY CONSUMPTION FOR CITY TRANSPORT

Table 5. Purchase and consumption of fuel and lubricants

		Quantity
1	**Trams/Underground**	
1.1.	Electricity consumption, MWh	
2	**Buses**	
2.1	Unleaded gasoline, t	
2.2.	Leaded gasoline, t	
2.3.	Transport diesel, t	
2.4.	Biodiesel	
2.5.	CNG	
2.6.	Other fuels (speficy kind and unit)	

ANNUAL QUESTIONNAIRE ON ENERGY CONSUMPTION USED FOR PIPELINE TRANSPORT

Table 5. Purchase and consumption of fuel

		Quantity
1.1.	Electricity consumption, MWh	
2.6.	Other fuels (speficy kind and unit)	

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Data collection and compilation, examples of questionnaires, modeling techinques examples of the results

DISSAGREGATED STATISTICS ON TRANSPORT SECTOR

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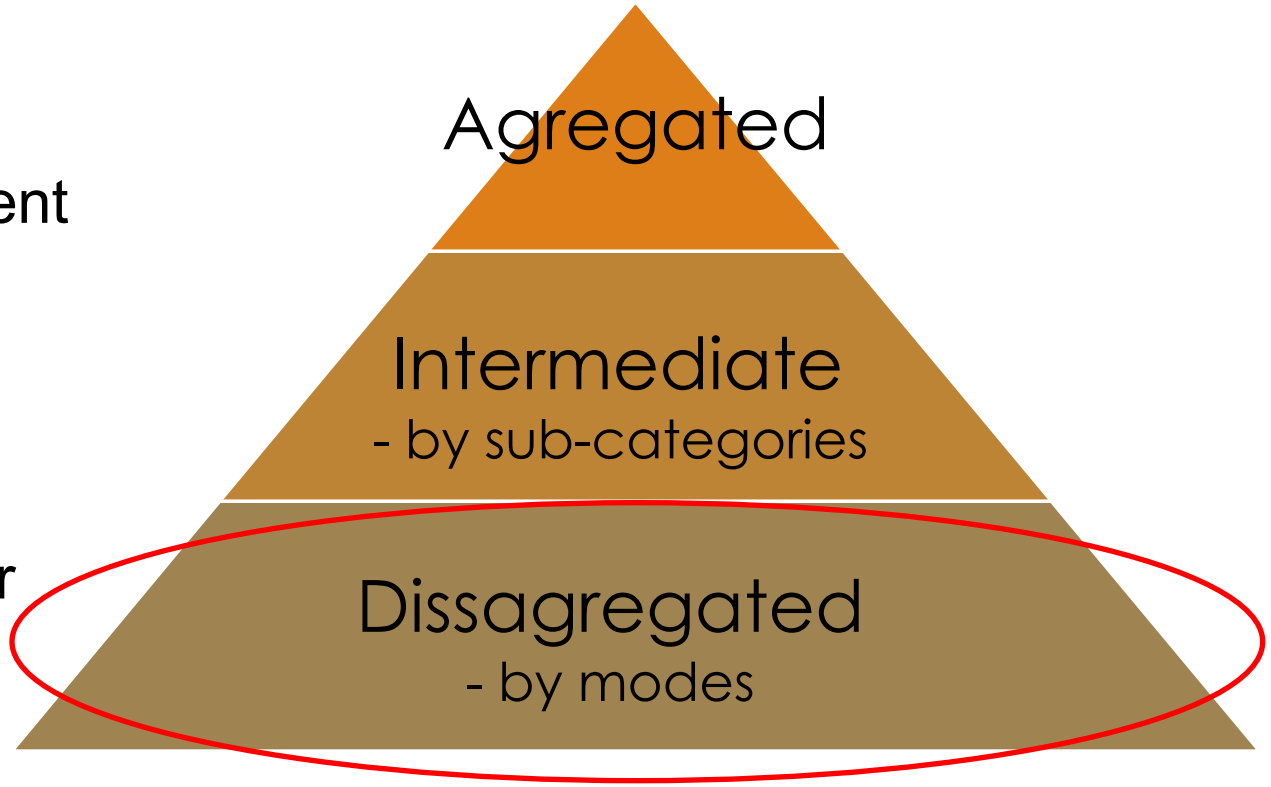
Structure of the indicators in transport sector

Disaggregated

Data sources: large datasets from different sources necessary

Indicators – final goal:

- Energy consumption per passenger kilometer
- Energy consumption per tone kilometer



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Sub-sectors, segments and modes in transportation sector

Dissagregated indicators

Segment Sub-sector	Passenger, koe/pkm	Freight, koe/tkm
Road	Personal Light Duty Vehicles - Personal cars - SUVs - Passanger light trucks Motorcycles Busses	Freight light-duty vehicles Heavy-duty vehicles Other (tractors on the roads, …)
Rail	Passenger rails - trains, metro vehicles, trams	Freight rails
Air	Passenger airplanes	Freight airplanes
Water	Passenger ships	Freight ships

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Data Requirements – activity

pkm = vkm x occupancy = stocks x average mileage x average occupancy

Passenger transport				Freight transport			
Road	Rail	Waterways	Air	Road	Rail	Waterways	Air
Personal cars	Passenger Trains	Passenger Ships	Passenger Airplanes	Trucks	Freight Trains	Freight Ships	Freight Airplanes
Buses							
Motorcycles							
- Passenger-kilometres (gasoline, diesel, LPG, ...)				Tonne-kilometres			
- Vehicle kilometres (gasoline, diesel, LPG, ...)				Tonnes			
- Number of vehicles in use (gasoline, diesel, LPG, ...)				Number of vehicles in use			

Vehicle stocks

- Mostly available in many countries (e.g. Ministries, Statistical offices)
- Can be estimated using vehicle data base
- Vehicle classification is not the same by countries

Average mileage & occupancy (load)

- Rarely available
- Can be found in household surveys, travel diaries, odometer readings in vehicle database, public transport utilities
- Often estimated

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Reporting to IEA on transport sector consumption and activity

TRANSPORT	units	2009	2010	2011	2012
Passenger transport [passenger-kilometres]					
Cars, SUV and personal light trucks	10^9 pass-km	0	0	0	0
- gasoline (spark ignition) engine	10^9 pass-km	0	0	0	0
- diesel (compression ignition) engine	10^9 pass-km	0	0	0	0
Motorcycles (2 wheelers) & 3 wheelers	10^9 pass-km	0	0	0	0
Buses	10^9 pass-km	0	0	0	0
Passenger Trains	10^9 pass-km	0	0	0	0
Domestic passenger airplanes	10^9 pass-km	0	0	0	0
Domestic passenger ships	10^9 pass-km	0	0	0	0
Total Passenger Transport	**10^9 pass-km**	**0**	**0**	**0**	**0**
Freight transport [tonne-kilometres]					
Freight & Commercial road transport	10^9 tonne-km	0	0	0	0
- gasoline (spark ignition) engine	10^9 tonne-km	0	0	0	0
- diesel (compression ignition) engine	10^9 tonne-km	0	0	0	0
Freight trains	10^9 tonne-km	0	0	0	0
Domestic freight airplanes	10^9 tonne-km	0	0	0	0
Domestic freight ships	10^9 tonne-km	0	0	0	0
Total Freight Transport	**10^9 tonne-km**	**0**	**0**	**0**	**0**
Freight transport [tonnes]					
Freight & Commercial road transport	10^6 tonnes	0	0	0	0
- gasoline (spark ignition) engine	10^6 tonnes	0	0	0	0
- diesel (compression ignition) engine	10^6 tonnes	0	0	0	0
Freight trains	10^6 tonnes	0	0	0	0
Domestic freight airplanes	10^6 tonnes	0	0	0	0

Source: IEA

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MODELLING CONSUMPTION IN TRANSPORT

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Development of model for indicators in transport sector

- Each sub-sector, segment and transport mode requires separate approach in data collection and modelling;
- Model is flexible, it allows including additional specific transport modes or excluding modes which are not relevant for a country
- Simple, easy to use, MS EXCEL based
- The quality of the model depends on the quality of input data;
- It is highly recommended to initiate modelling with existing data and estimating missing data using international benchmarks only for the purposes of developing and running the model;
- Data for modelling transport sector is time consuming activity.

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Development of model for estimating indicators in transport sector (continuation)

- Proposed model includes the following segments:

✓Road passenger

✓Road freight

✓Road total → comparison with energy balance data

✓Rail passenger

✓Rail freight

✓Rail total → comparison with energy balance data

✓Air and Water

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Modelling passenger road transport (1/8 STEPS)
STEP 1: Identification of Vehicle stock number

- time series of data on total number are available in national transport statistics data base
- number of cars by type of engine rarely available in national statistics, usually available in national vehicle stock databases

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1.	**Vehicle stocks, number**		**70,17**	**78,58**	**87,01**	**96,99**	**106,00**	**107,15**	**108,01**	**114,31**	**121,68**	**128,90**	**131,23**
	CARS, SUVS AND PERSONAL LIGHT TRUCKS		**8,89**	**9,55**	**10,43**	**10,54**	**11,56**	**12,42**	**13,28**	**13,90**	**14,80**	**15,90**	**15,97**
	gasoline	mil.	3,56	3,72	3,96	3,90	4,16	4,35	4,51	4,59	4,74	4,93	4,79
	diesel	mil.	5,33	5,82	6,45	6,61	7,35	8,01	8,68	9,22	9,95	10,83	11,02
	electric	mil.	0,00	0,01	0,02	0,03	0,05	0,06	0,08	0,10	0,12	0,14	0,16
	other	mil.											
	MOTORCYCLES												
	gasoline	mil.	**61,08**	**68,84**	**76,38**	**86,25**	**94,24**	**94,53**	**94,53**	**100,20**	**106,66**	**112,77**	**115,02**
	other	mil.											
	BUSES												
	gasoline	mil.											
	diesel	mil.	**0,20**	**0,20**	**0,20**	**0,20**	**0,20**	**0,20**	**0,20**	**0,21**	**0,22**	**0,23**	**0,23**
	electric	mil.											
	LNG	mil.											
	other	mil.											

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Modelling passenger road transport (2/8 STEPS)
STEP 2: Identification of Average annual distance travelled

- data is rarely available in national official statistics
- usually available in national vehicle stock databases, various surveys' results, scientific papers

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
2.	**Average annual distance traveled**												
	CARS, SUVS AND PERSONAL LIGHT TRUCKS												
	gasoline	km	16.609	16.777	16.947	17.118	17.291	17.465	17.642	17.820	18.000	18.000	18.000
	diesel	km	19.931	20.133	20.336	20.541	20.749	20.958	21.170	21.384	21.600	21.600	21.600
	electric	km											
	other	km											
	MOTORCYCLES												
	gasoline	km	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800	3.800
	other	km											
	BUSES												
	gasoline	km											
	diesel	km	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000	50.000
	electric	km											
	LNG	km											
	other												

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Modelling passenger road transport (3/8 STEPS))
STEP 3: Identification of Total annual distance travel

Total annual distance travel = Number of vehicles * Average annual distance travel

** formulas in model are colored in blue*

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
3.	**Total annual distance travel, vehicle-km**												
	CARS, SUVS AND PERSONAL LIGHT TRUCKS												
	gasoline	mil.veh-km	147.675	160.203	176.792	180.422	199.898	216.990	234.248	247.698	266.400	286.200	287.460
	diesel	mil.veh-km	70.884	74.975	80.617	80.107	86.356	91.136	95.573	98.088	102.298	106.466	103.486
	electric	mil.veh-km	0	0	0	0	0	0	0	0	0	0	0
	other	mil.veh-km	0	0	0	0	0	0	0	0	0	0	0
	MOTORCYCLES												
	gasoline	mil.veh-km	232.097	261.589	290.248	327.761	358.123	359.218	359.218	380.760	405.297	428.530	437.087
	other	mil.veh-km	0	0	0	0	0	0	0	0	0	0	0
	BUSES												
	gasoline	mil.veh-km	0	0	0	0	0	0	0	0	0	0	0
	diesel	mil.veh-km	9.800	9.800	9.800	9.800	9.800	9.800	10.200	10.650	11.100	11.550	11.650
	electric	mil.veh-km	0	0	0	0	0	0	0	0	0	0	0
	LNG	mil.veh-km	0	0	0	0	0	0	0	0	0	0	0
	other	mil.veh-km	0	0	0	0	0	0	0	0	0	0	0

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Modelling passenger road transport (4/8 STEPS)
STEP 4: Identification of Average occupancy per vehicle

- indicator shows an average number of passenger in transport mode during a drive
- very rarely available data in official statistics, data are usually collected in the frame of various surveys or observations

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
4.	**AVERAGE OCCUPANCY PER VEHICLE, passangers**												
	CARS, SUVS AND PERSONAL LIGHT TRUCKS												
	gasoline	pass/vehicle	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
	diesel	pass/vehicle	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
	electric	pass/vehicle	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
	other	pass/vehicle	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3	1,3
	MOTORCYCLES												
	gasoline	pass/vehicle	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
	other	pass/vehicle	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
	BUSES												
	gasoline	pass/vehicle	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
	diesel	pass/vehicle	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
	electric	pass/vehicle	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
	LNG	pass/vehicle	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00
	other	pass/vehicle	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00	10,00

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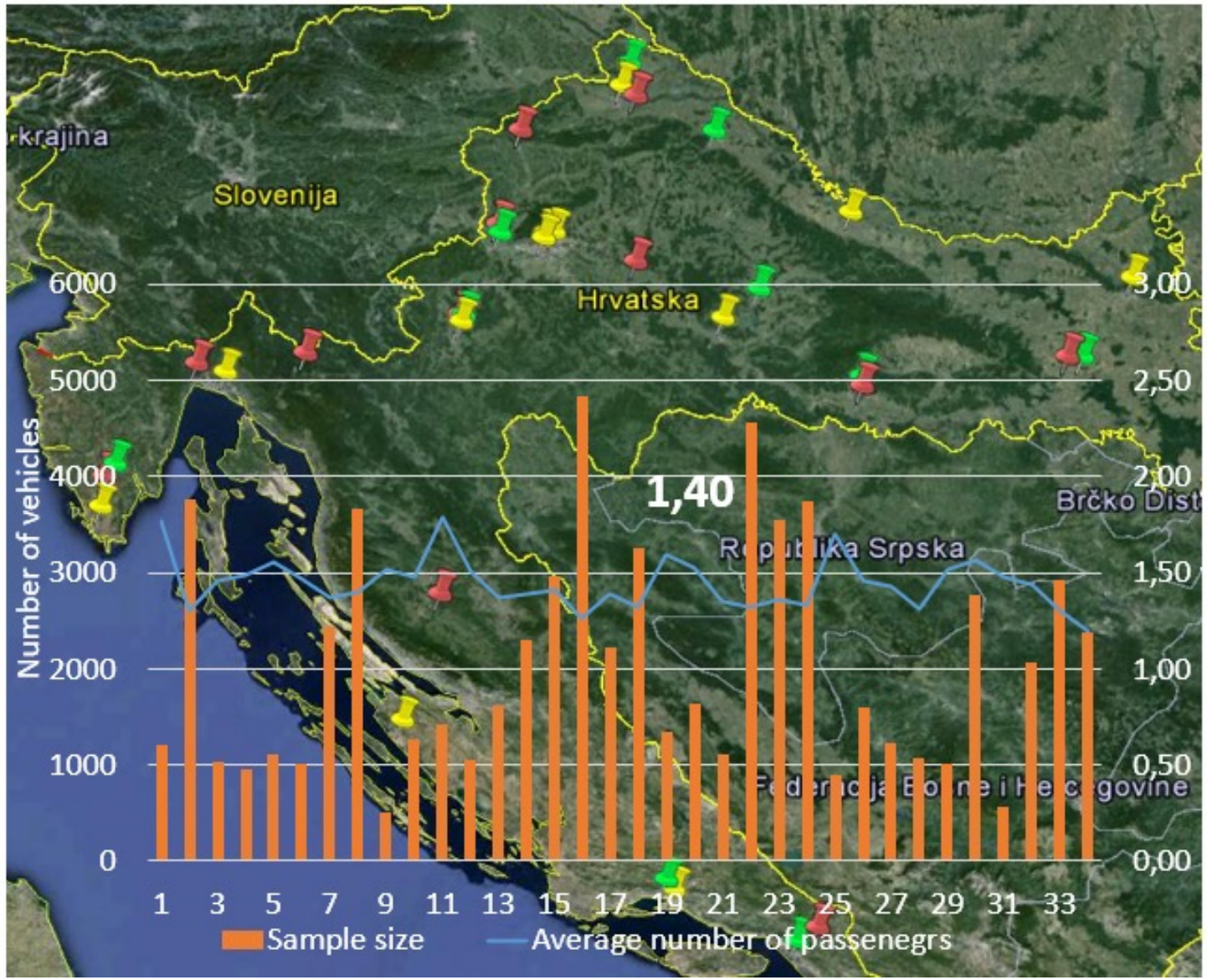

Survey on passenger cars' occupancy in CROATIA:

1,4 pass/car

Interurban roads

Cities

Highways

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Modelling passenger road transport (5/8 STEPS)
STEP 5: Identification of Total passenger kilometers

- Total passenger kilometer = Total annual distance travelled * passenger load
- this information is very often available in national statistics, but methodology and approach for its calculation should be checked

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
5.	**PASSANGER KILOMETRE**												
	CARS, SUVS AND PERSONAL LIGHT TRUCKS												
	gasoline	mil.pass-km	191.977	208.264	229.829	234.548	259.868	282.087	304.522	322.007	346.320	372.060	373.698
	diesel	mil.pass-km	92.149	97.468	104.802	104.139	112.263	118.476	124.245	127.515	132.987	138.406	134.531
	electric	mil.pass-km	0	0	0	0	0	0	0	0	0	0	0
	other	mil.pass-km	0	0	0	0	0	0	0	0	0	0	0
	MOTORCYCLES												
	gasoline	mil.pass-km	232.097	261.589	290.248	327.761	358.123	359.218	359.218	380.760	405.297	428.530	437.087
	other	mil.pass-km	0	0	0	0	0	0	0	0	0	0	0
	BUSES												
	gasoline	mil.pass-km	0	0	0	0	0	0	0	0	0	0	0
	diesel	mil.pass-km	98.000	98.000	98.000	98.000	98.000	98.000	102.000	106.500	111.000	115.500	116.500
	electric	mil.pass-km	0	0	0	0	0	0	0	0	0	0	0
	LNG	mil.pass-km	0	0	0	0	0	0	0	0	0	0	0
	other	mil.pass-km	0	0	0	0	0	0	0	0	0	0	0

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Modelling passenger road transport (6/8 STEPS)
STEP 6: Identification of Average fuel consumption per 100 km

- this information is very often available in expert studies, scientific researches
- due to the fast changes in specific energy consumption per 100 km, many models includes separate models for „old" and „new" cars
- purple color in model shows „assumed" values, based on international benchmarks

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
6.	**AVERAGE FUEL CONSUMPTION**												
	CARS, SUVS AND PERSONAL LIGHT TRUCKS												
	gasoline	lit/100 km	9,95	9,85	9,75	9,66	9,56	9,46	9,37	9,28	9,18	9,09	9,00
	diesel	lit/100 km	9,69	9,59	9,49	9,40	9,30	9,21	9,12	9,03	8,94	8,85	8,76
	electric	kWh/100 km	55	55	54	54	53	52	52	51	51	50	50
	other	lit/100 km											
	MOTORCYCLES												
	gasoline	lit/100 km	4,87	4,82	4,77	4,72	4,67	4,63	4,58	4,53	4,49	4,44	4,40
	other	lit/100 km											
	BUSES												
	gasoline	lit/100 km	28,75	28,46	28,18	27,90	27,62	27,34	27,07	26,80	26,53	26,26	26
	diesel	lit/100 km	48,65	48,17	47,68	47,21	46,73	46,27	45,80	45,35	44,89	44,44	44
	electric	kWh/100 km	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0
	LNG	lit/100 km	16,59	16,42	16,26	16,09	15,93	15,77	15,62	15,46	15,30	15,15	15
	other	lit/100 km	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0

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Modelling passenger road transport (7/8 STEPS)
STEP 7: Identification of Fuel consumption of transport modes

- Total fuel consumption = Average fuel consumption /100 km /100 * Distance travelled
- Specific consumption per vehicles: Total fuel consumption / number of vehicles

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
7.	**TOTAL FUEL CONSUMPTION**												
	CARS, SUVS AND PERSONAL LIGHT TRUCKS												
	gasoline	TJ	187.781	201.675	220.332	222.608	244.172	262.399	280.435	293.572	312.580	332.455	330.579
	diesel	TJ	86.301	90.369	96.198	94.634	100.995	105.520	109.551	111.310	114.925	118.413	113.946
	electric	TJ	0	0	0	0	0	0	0	0	0	0	0
	other	TJ	0	0	0	0	0	0	0	0	0	0	0
	Total	TJ	274.082	292.044	316.530	317.242	345.167	367.918	389.986	404.882	427.506	450.867	444.525
	Total per car	MJ/car	30.827	30.584	30.341	30.099	29.856	29.613	29.371	29.128	28.886	28.356	27.835
	MOTORCYCLES												
	gasoline	TJ	135.661	151.370	166.274	185.886	201.075	199.672	197.676	207.435	218.594	228.814	231.049
	other	TJ	0	0	0	0	0	0	0	0	0	0	0
	Total	TJ	135.661	151.370	166.274	185.886	201.075	199.672	197.676	207.435	218.594	228.814	231.049
	Total per motor vehicle	MJ/motorcyc	2.221	2.199	2.177	2.155	2.134	2.112	2.091	2.070	2.050	2.029	2.009
	BUSES												
	gasoline	TJ	0	0	0	0	0	0	0	0	0	0	0
	diesel	TJ	59.930	59.331	58.737	58.150	57.568	56.993	58.726	60.703	62.636	64.523	64.431
	electric	TJ	0	0	0	0	0	0	0	0	0	0	0
	LNG	TJ	0	0	0	0	0	0	0	0	0	0	0
	other	TJ	0	0	0	0	0	0	0	0	0	0	0
	Total	TJ	59.930	59.331	58.737	58.150	57.568	56.993	58.726	60.703	62.636	64.523	64.431
	Total per bus	MJ/bus	305.764	302.707	299.680	296.683	293.716	290.779	287.871	284.992	282.142	279.321	276.528

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Modelling passenger road transport (8/8 STEPS)
STEP 8: CALCULATION OF INDICATORS

- Transport indicators = Total fuel consumption / Total passenger-kilometre
- Decreasing energy efficiency indicators leads to the conclusions that there are improvements in efficiency in energy use; lower fuel consumption /100 km, more passengers per transport modes, etc.
- - International benchmarks available in ODYSSEE database (EU countries)

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
8.	ENERGY EFFICIENCY INDICATORS AND COMPARISON WITH EU RANGES												
	CARS, SUVS AND PERSONAL LIGHT TRUCI	MJ/pass-km	0,965	0,955	0,946	0,937	0,928	0,919	0,910	0,901	0,892	0,883	0,875
	MOTORCYCLES	MJ/pass-km	0,584	0,579	0,573	0,567	0,561	0,556	0,550	0,545	0,539	0,534	0,529
	BUSES	MJ/pass-km	0,612	0,605	0,599	0,593	0,587	0,582	0,576	0,570	0,564	0,559	0,553
	TOTAL												
	CARS, SUVS AND PERSONAL LIGHT TRUCI	koe/pkm	0,023	0,022	0,022	0,022	0,022	0,022	0,021	0,021	0,021	0,021	0,021
	MOTORCYCLES	koe/pkm	0,014	0,014	0,013	0,013	0,013	0,013	0,013	0,013	0,013	0,013	0,012
	BUSES	koe/pkm	0,014	0,014	0,014	0,014	0,014	0,014	0,013	0,013	0,013	0,013	0,013

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Modelling freight road transport (1/8 STEPS) .....
STEP 1: Identification of Vehicle stock number

- the basic disaggregation per transport mode is considered
- additional disaggregation can include: light freight vehicles, heavy freight vehicles, new vehicles….

			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1.	**Vehicle stocks, number**												
	FREIGHT COMMERCIAL TRANSPORT	mil.	**3,10**	**3,30**	**3,50**	**3,70**	**3,90**	**4,10**	**4,30**	**4,50**	**4,70**	**5,00**	**5,00**
	gasoline	mil.	1,55	1,62	1,68	1,74	1,79	1,85	1,89	1,94	1,97	2,05	2,00
	diesel	mil.	1,55	1,68	1,81	1,95	2,09	2,23	2,38	2,53	2,69	2,91	2,95
	electric	mil.	0,00	0,00	0,01	0,01	0,02	0,02	0,03	0,03	0,04	0,05	0,05
	other												

- REPEAT ALL OTHER STEPS AS PER PASSENGER ROAD TRANSPORT!

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Completion of modelling ROAD transport (1/2)

The final stage in modelling road transport is aggregation of consumption of road passenger and road fright transport and comparison with national energy balance data.

Total by type of FUEL			2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	0
2.1	TOTAL ROAD TRANSPORT - MODEL												
	gasoline	TJ	858192	922295	990357	1046744	1117997	1169321	1219861	1277257	1341925	1423768	1424128
	diesel	TJ	485229	503351	522365	533117	550926	566029	582073	595214	609291	631288	615794
	electric	TJ	0	0	0	0	0	0	0	0	0	0	0
	LNG	TJ	0	0	0	0	0	0	0	0	0	0	
	other	TJ	0	0	0	0	0	0	0	0	0	0	0
	TOTAL	TJ	1.343.421	1.425.646	1.512.722	1.579.862	1.668.923	1.735.350	1.801.934	**1.872.471**	**1.951.216**	**2.055.056**	**2.039.922**

2.2.	IEA/ENERGY BALANCE DATA										
	Total Energy Use in Road Transport	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	
	From the APEC energy balances:											
	Motor Gasoline (including biofuels)	791,63	877,41	971,05	1.012,17	1.012,17	1.048,32	1.092,58	1.133,22	1.167,18	1.206,82	0
	Automotive Diesel (including biofuels)	424,34	608,65	796,72	802,61	807,42	789,07	621,45	712,96	831,52	833,07	0
	LPG (Liquefied Petroleum Gas)	0	0	0	0	0	0	0	0	0	0	0
	Natural Gas	1,11	1,03	0,87	1,05	1,18	1,40	1,16	0,52	1,33	1,13	0
	Electricity	0	0	0	0	0	0	0	0	0	0	0
	Other	0	0	0	0	0	0	0	0	0	0	0
	Total	**1.217,08**	**1.487,09**	**1.768,64**	**1.815,83**	**1.820,76**	**1.838,79**	**1.715,20**	**1.846,71**	**2.000,02**	**2.041,02**	**0**

MUST BE EQUAL!!!!

Completion of modelling ROAD transport (2/2)

- MAKE DECISION HOW TO IMPROVE DATA !!!!

Difference between modelled data and IEA data												
TOTAL ROAD TRANSPORT		2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Gasoline	%	7,76	4,87	1,95	3,30	9,47	10,35	10,43	11,28	13,02	15,24	100
Diesel	%	12,55	-20,92	-52,52	-50,55	-46,56	-39,41	-6,77	-19,78	-36,47	-31,96	100
LPG	%	-	-	-	-	-	-	-	-	-	-	-
Natural Gas	%	-	-	-	-	-	-	-	-	-	-	-
Electricity	%	-	-	-	-	-	-	-	-	-	-	-
Other		-	-	-	-	-	-	-	-	-	-	-
TOTAL		9,40	-4,31	-16,92	-14,94	-9,10	-5,96	4,81	1,38	-2,50	0,68	100

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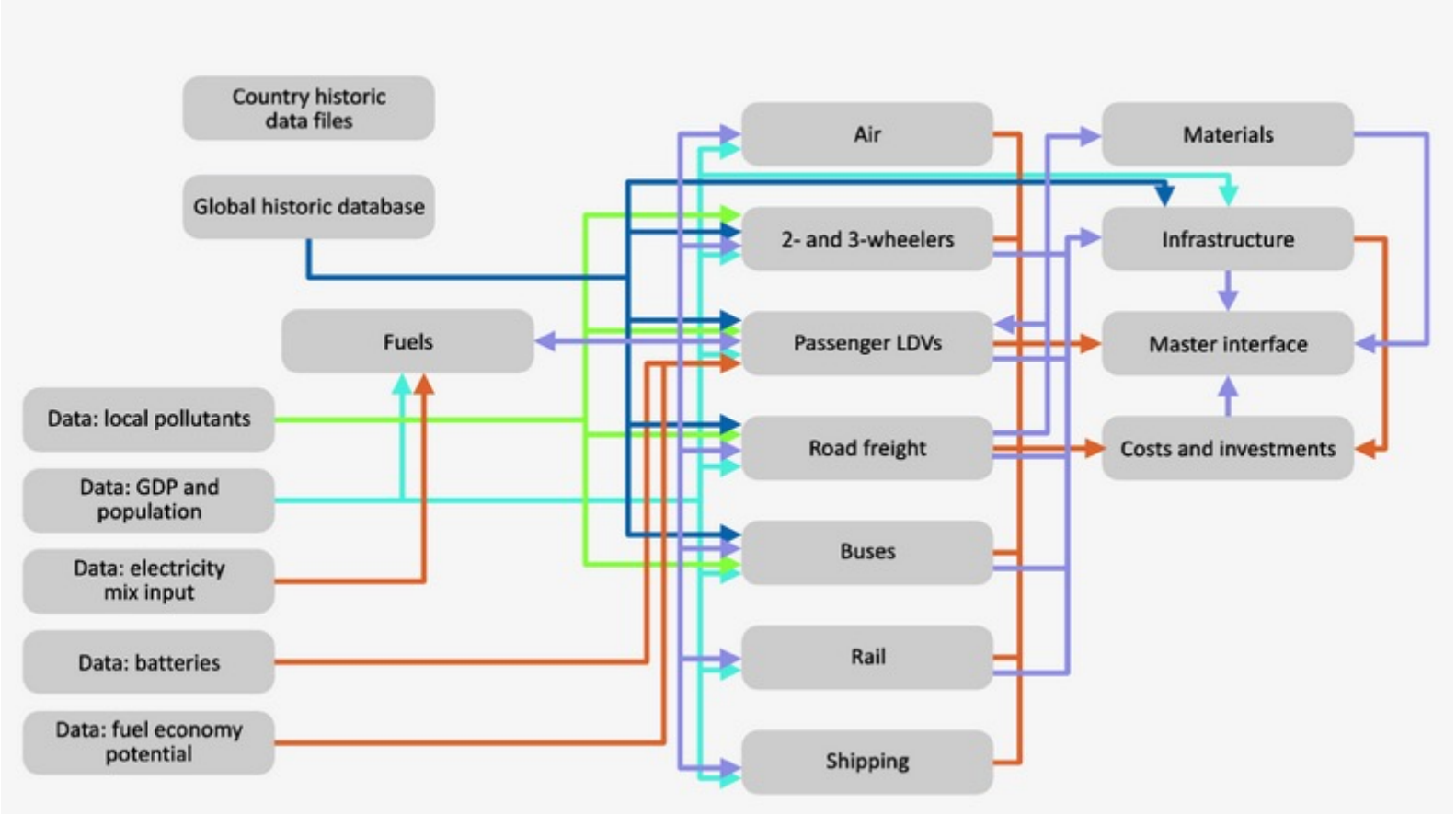
Modelling of the transport sector: MOBILITY MODEL



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Examples of good practices

Hong Kong

表格 Table 57

客運組別所有能源使用按最終用途劃分

Total Energy Consumption in Passenger Segment by End-use

單位 Unit：太焦耳 Terajoule

	巴士 Bus	的士 Taxi	汽車 Car	電單車 Motorcycle	鐵路 Rail	船隻 Marine	其他 Others	總計 Total
2007	19,832	14,102	17,118	463	2,495	3,758	215	57,983
2008	18,971	15,142	17,059	480	2,520	3,758	207	58,137
2009	19,150	13,131	17,449	465	2,523	3,810	190	56,718
2010	18,842	13,373	18,247	436	2,540	3,930	193	57,560
2011	18,911	13,593	18,795	425	2,609	4,110	103	58,546
2012	19,128	13,469	19,432	421	2,722	4,251	102	59,526
2013	19,144	13,319	20,955	411	2,796	4,434	102	61,161
2014	19,285	13,696	20,815	424	2,875	4,441	106	61,641
2015	19,168	12,437	21,764	448	2,972	4,523	108	61,421
2016	18,918	12,288	22,880	462	2,951	4,512	124	62,136
2017	**18,663**	**10,686**	**22,996**	**489**	**3,129**	**4,511**	**147**	**60,622**

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ODYSEE-MURE:
EU ENERY EFFICIENCY INDICATORS DATABASE

The general objective of EU project: ODYSSEE-MURE

- To provide a comprehensive monitoring of energy consumption and efficiency trends as well as an evaluation of energy efficiency policy measures by sector for EU countries and Norway.
- Evaluate and compare energy efficiency progress by sector, and relate this progress to the observed trends in energy consumption.
- Contribute to the evaluation of national energy efficiency policy measures and analyze the dynamics of implementation over the NEAAPs.

http://www.odyssee-mure.eu/

- ODYSEE - contains detailed energy efficiency and CO2-indicators with data on energy consumption, their drivers (activity indicators) and their related CO2-emissions.
- MURE - contains a description, with their impact evaluation of all energy efficiency measures implemented at EU or national level.

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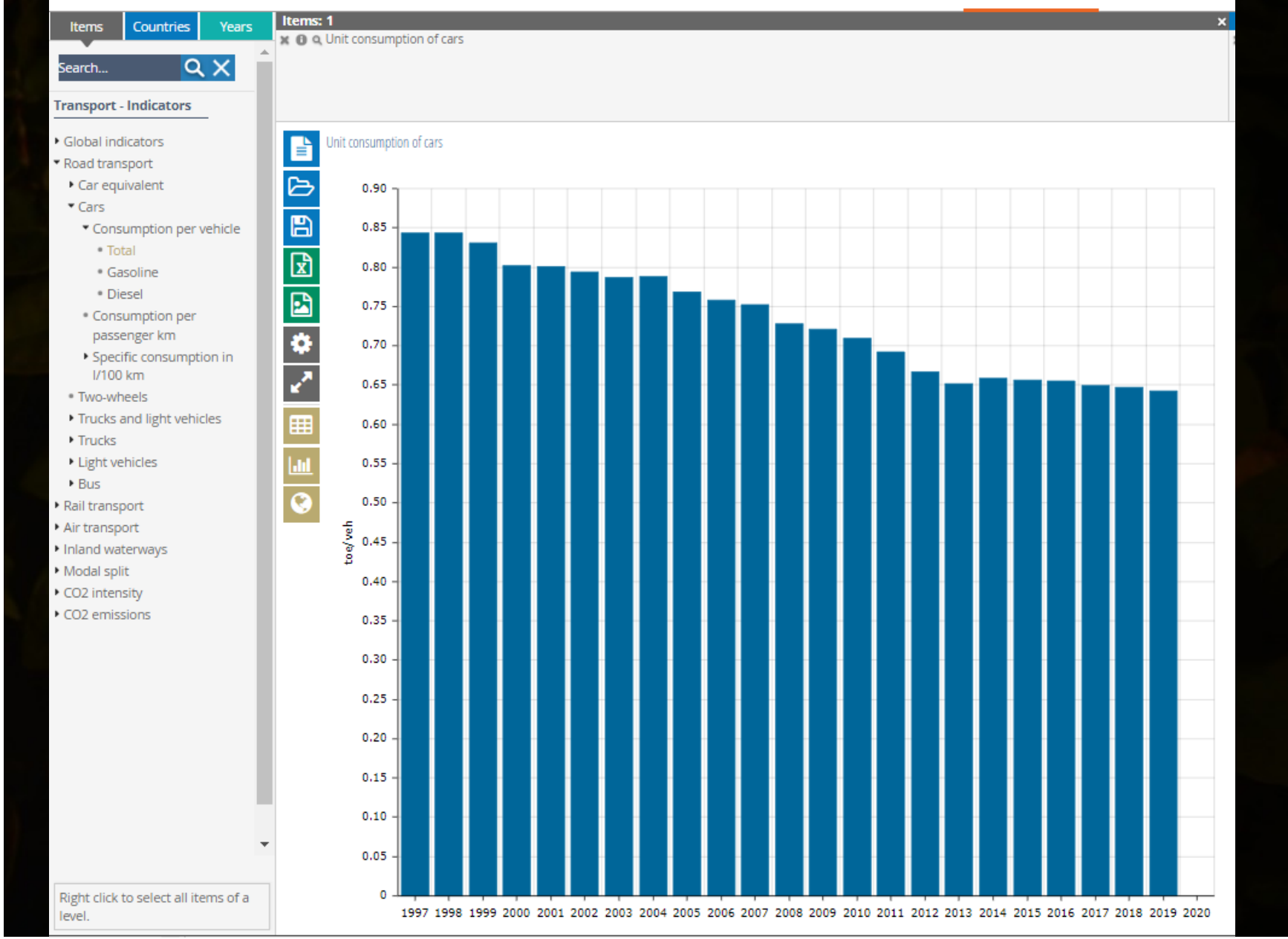
SOURCE: ODYSSEE DATABASE

EUROPEAN UNION: AVERAGE FUEL CONSUMPTION IN PERSONAL CARS, TOE/VEHICLE



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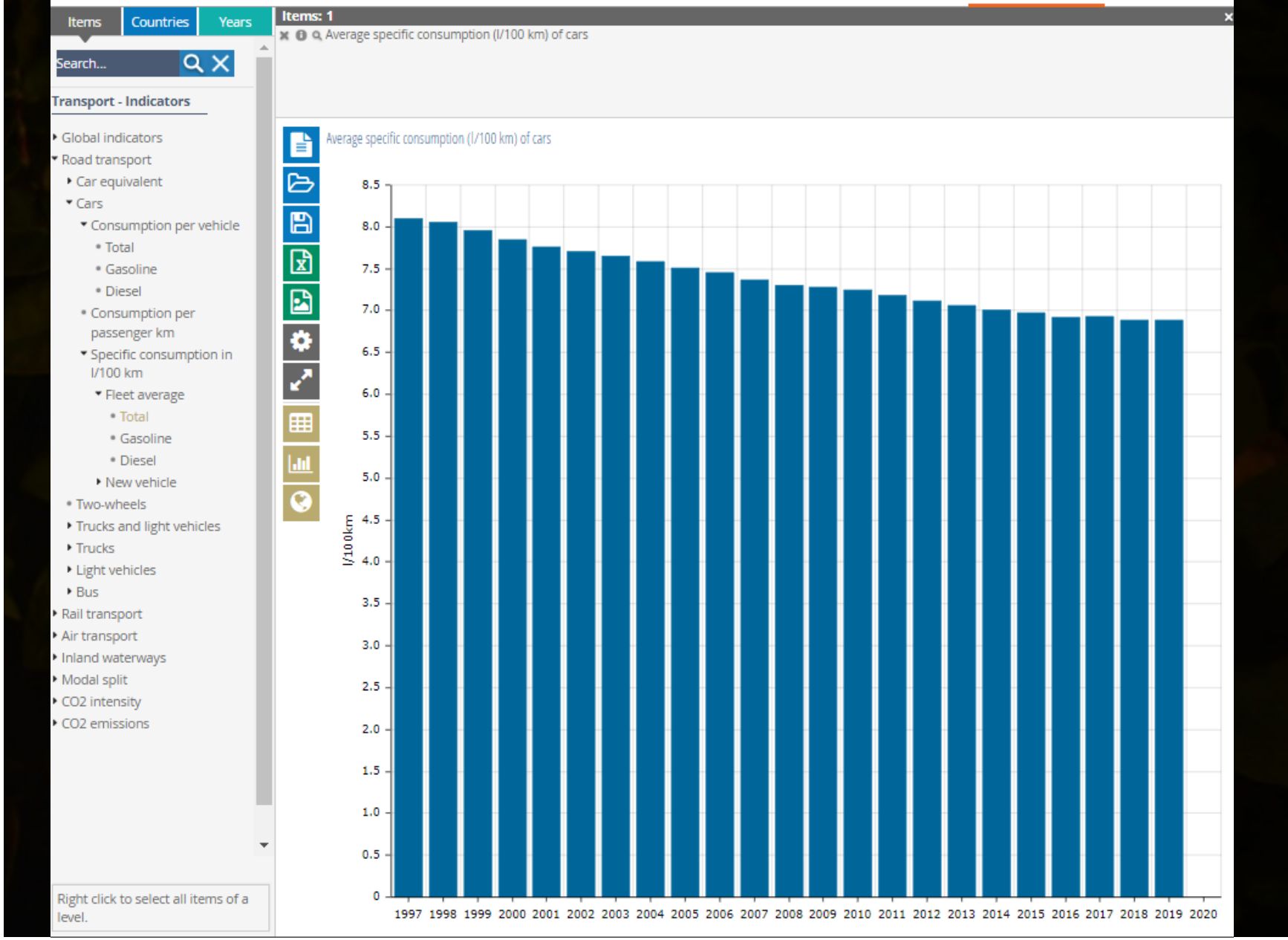
SOURCE: ODYSSEE DATABASE

EUROPEAN UNION: AVERAGE FUEL CONSUMPTION IN PERSONAL CARS IN EU, LIT/100 KM



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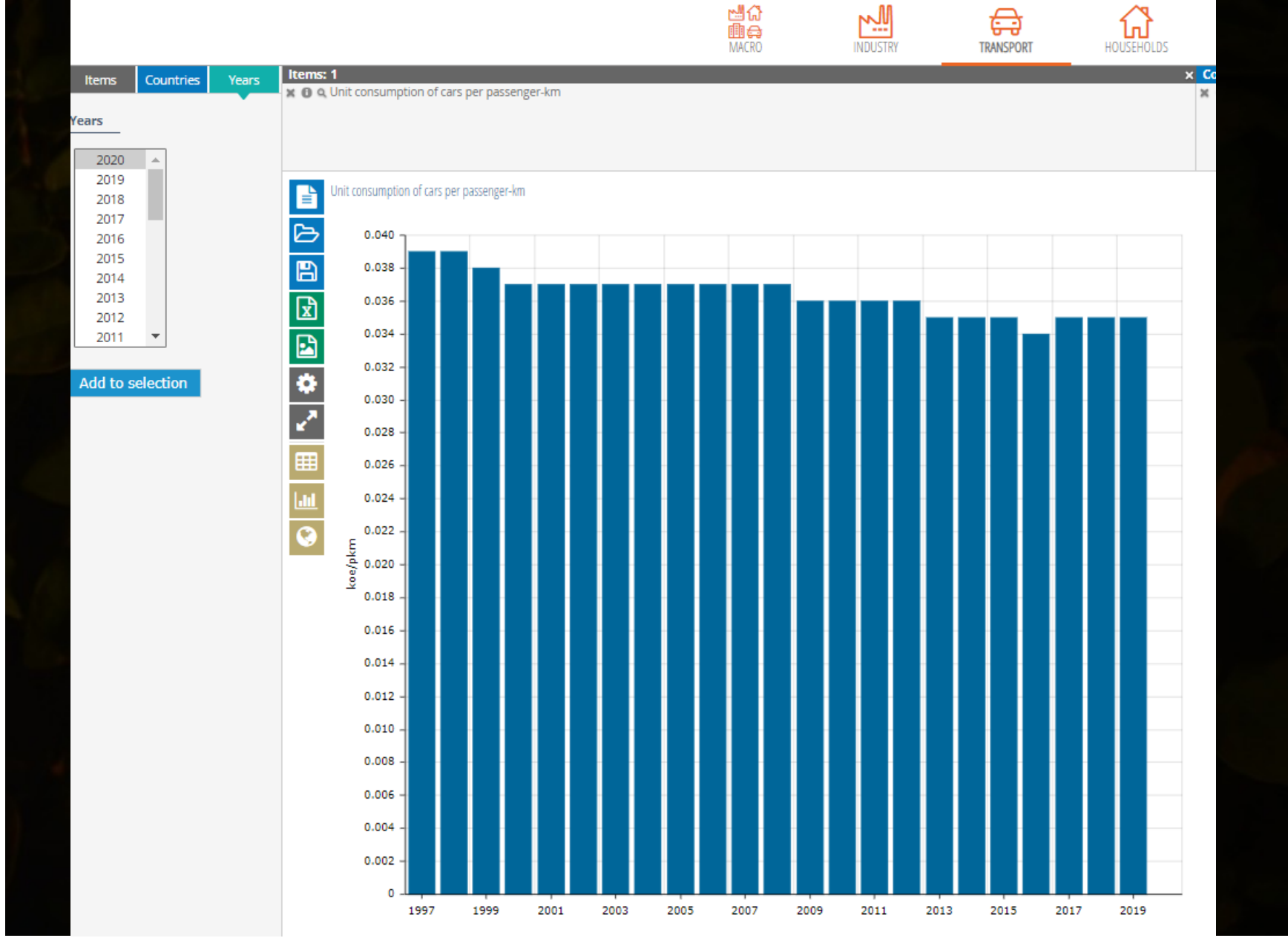
SOURCE: ODYSSEE DATABASE

EUROPEAN UNION: ENERGY INTENSITY OF PERSONAL CARS IN EU, KOE/PKM



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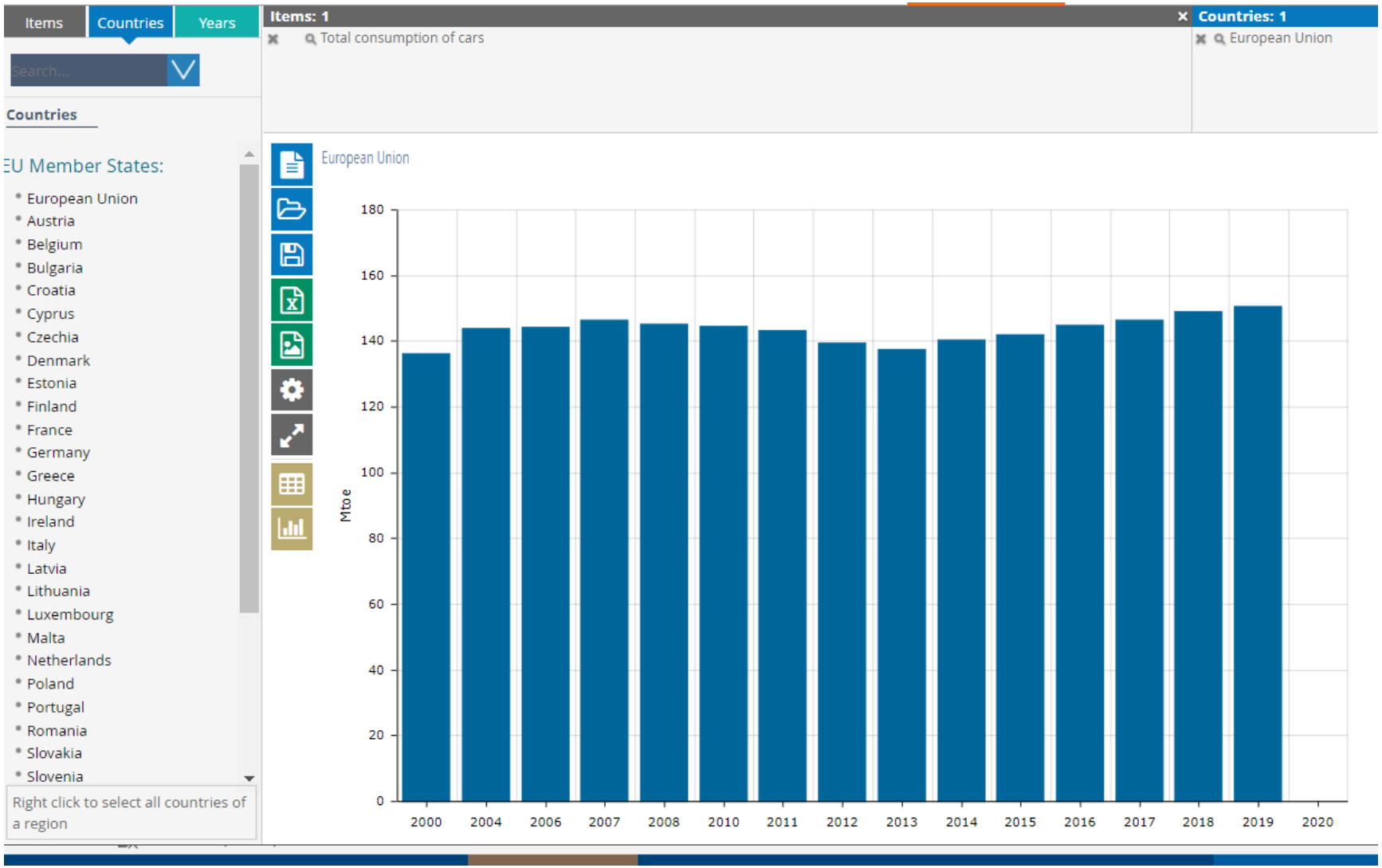
?

EUROPEAN UNION, TOTAL FUEL CONSUMPTION IN PERSONAL CARS, MTOE



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CROATIAN EXPERIENCES

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Setting up the model – identification of necessary data

Comprehensive model of energy data collection developed

- bottom-up approach;
- detailed energy consumption by mode of transport;
- accurate and detailed data on vehicle km, p-km, t-km, fuel consumption, relative efficiency, etc..

Necessary data (annual statistics)

- Energy consumption (by type of transport, vehicle category and by fuel)
- Kilometers travelled in passenger traffic (by vehicle category)
- Goods carried (by vehicle category)
- Passenger-kilometers (cars, buses, rail)
- Tonne-kilometres (freight vehicles, rail, sea and inland waterways)

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Assessment of available data and new surveys initiated

- **Identified database of all registered vehicles:** km travelled, type and power of engine, year of production, fuel type, vehicle category managed by „Centre for vehicle"
- **Energy consumption in rail transport, maritime and inland waterway** transport and air transport available in national statistics

- **New survey established:**
  - Survey on the average occupancy of personal cars;
  - Survey on energy consumption of tourist's and other transit cars and buses;
  - Survey on energy consumption and tonne kilometres for light duty vehicles;
  - Survey on fuel consumption in marinas.

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Survey for light duty vehicles: Questionnaire

3. INFORMATION ON N1 CATEGORY OF VEHICLES (gross vehicle weight of less than 3.500 kg)						
Fuel type	Engine power	Carrying capacity	Annual mileage of vehicle	Share of annual mileage of loaded vehicle	Average load of vehicle	Average consumption of vehicle
	kW	kg	km	%	kg	l/100 km
A	B		C	D	E	F

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Survey of tourist's and transit vehicles: RESULTS

Motor gasoline	No. of surveyed cars	1006
	Share of gasoline cars	36,2%
	Average mileage in Croatia	852
	Average fuel consumption	7,5
	Total no. of foreign cars	13.473.000
	Average passenger load	2,49
	Total consumption of foreign cars (l)	84.103.323
	Total passenger transport (Mpkm)	2.798
Dizel	No. of surveyed cars	2373
	Share of diesel cars	59,4%
	Average mileage in Croatia	889,0
	Average fuel consumption	6,2
	Total no. of foreign cars	13.473.000
	Average passenger load	2,80
	Total consumption of foreign cars (l)	145.177.642
	Total passenger transport (Mpkm)	6.564
FOREIGN CARS	**CONSUMPTION OF MOTOR GASOLINE (1000 l)**	84.998,18
	CONSUMPTION OF DIESEL (1000 l)	145.177,64
	CONSUMPTION OF LPG (1000 l)	8.053,69

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M1 category (personal cars) of vehicles: MODEL

Category of vehicle	Fuel type	Year of production	Engine power (kW)	Number of vehicles at the end of 2012.;2013.*	Total annual mileage (reg.2013 - reg.2012)	Average annual mileage (km/vehicle)	Average fuel consumption - base fuel (l/100km)
M1	Diesel	do 1990.	<50	28.768	280.707.539	9.758	5,6
			51-60	10.585	103.389.838	9.768	5,8
			61-70	2.293	22.905.271	9.989	6,3
			71-80	373	3.840.202	10.295	6,6
			81-100	463	5.254.937	11.350	7,7
			101-130	36	539.363	14.982	8,2
			131-160	2	3.365	1.683	8,7
			>160	1		0	9,6
M1	Diesel	1991.-1995.	<50	23.884	289.912.444	12.138	5,6
			51-60	20.865	260.109.842	12.466	5,9
			61-70	14.058	194.624.514	13.844	6,3
			71-80	718	7.748.149	10.791	6,7
			81-100	2.520	33.424.521	13.264	7,6
			101-130	562	8.561.148	15.233	7,9
			131-160			0	8,6
			>160	1	18.165	18.165	9,3

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FINAL RESULTS

TOTAL ROAD TRANSPORT	DIESEL CONSUMPTION (1000 l)	1.352.048
	MOTOR GASOLINE CONSUMPTION (1000 l)	752.539
	LPG CONSUMPTION (1000 l)	77.961
	CNG CONSUMPTIONJ (1000 kg)	746
	TOTAL PASSENGER-KILOMETRES (1000000 pkm)	41.296
	TOTAL TONNE-KILOMETRES (1000000 tkm)	10.031
TOTAL WATER TRANSPORT	DIESEL CONSUMPTION (1000 l)	66.862
	MOTOR GASOLINE CONSUMPTION (1000 l)	10.931
	LPG CONSUMPTION (1000 l)	
	CNG CONSUMPTIONJ (1000 kg)	
	TOTAL PASSENGER-KILOMETRES (1000000 pkm)	444
	TOTAL TONNE-KILOMETRES (1000000 tkm)	224
TOTAL RAIL TRANSPORT	DIESEL CONSUMPTION (1000 l)	27.957
	MOTOR GASOLINE CONSUMPTION (1000 l)	
	LPG CONSUMPTION (1000 l)	
	CNG CONSUMPTIONJ (1000 kg)	
	TOTAL PASSENGER-KILOMETRES (1000000 pkm)	809
	TOTAL TONNE-KILOMETRES (1000000 tkm)	914
TOTAL AIR TRANSPORT	JET AND AVIATION FUEL CONSUMPTION (1000 kg)	123.800
	MOTOR GASOLINE CONSUMPTION (1000 l)	672
	TOTAL PASSENGER-KILOMETRES (1000000 pkm)	
	TOTAL TONNE-KILOMETRES (1000000 tkm)	0,227

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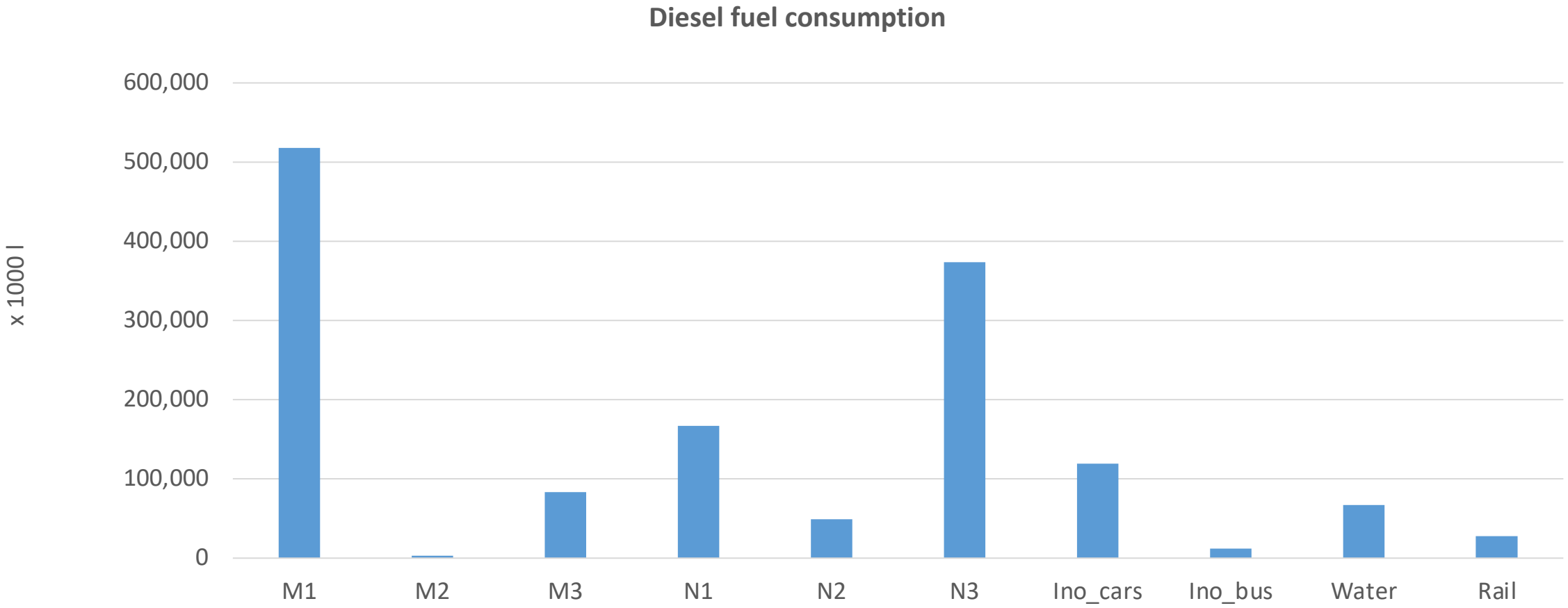
Diesel consumption in transport



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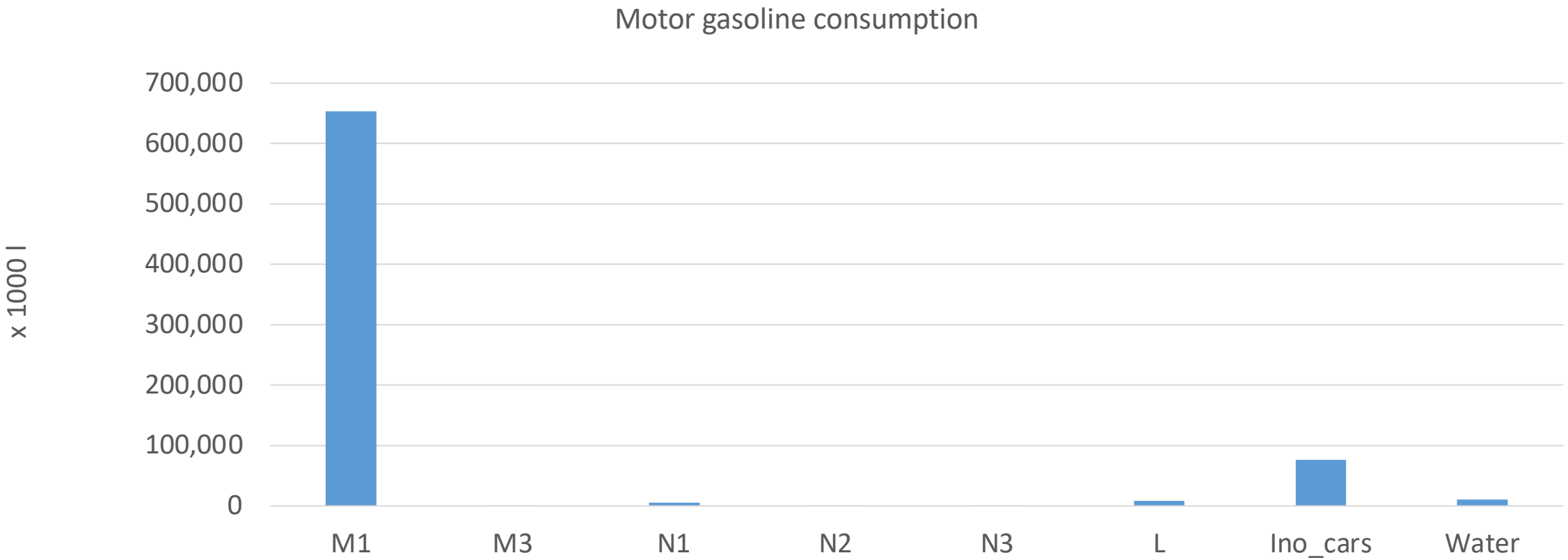
Gasoline consumption in transport



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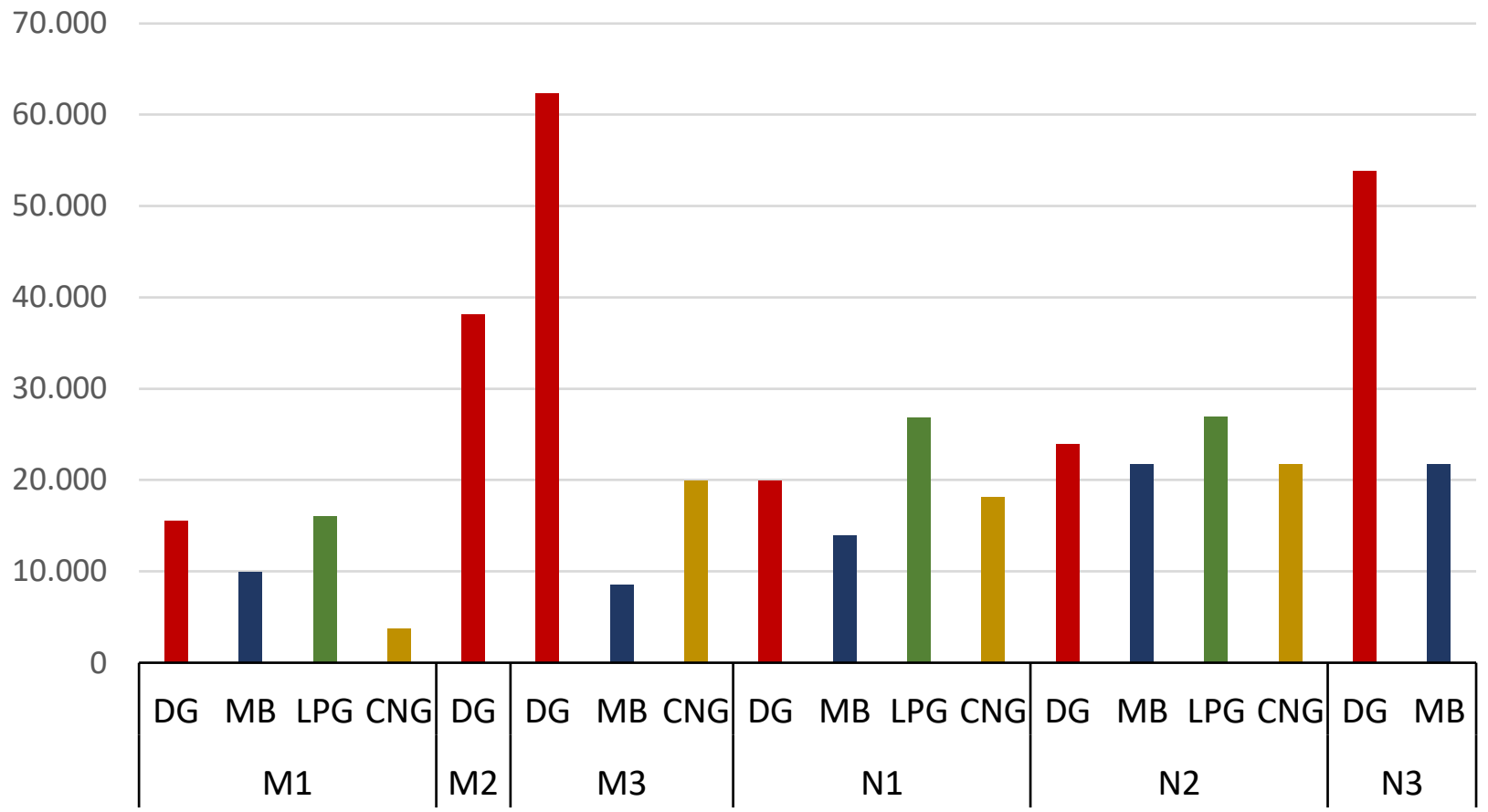
Average annual mileage



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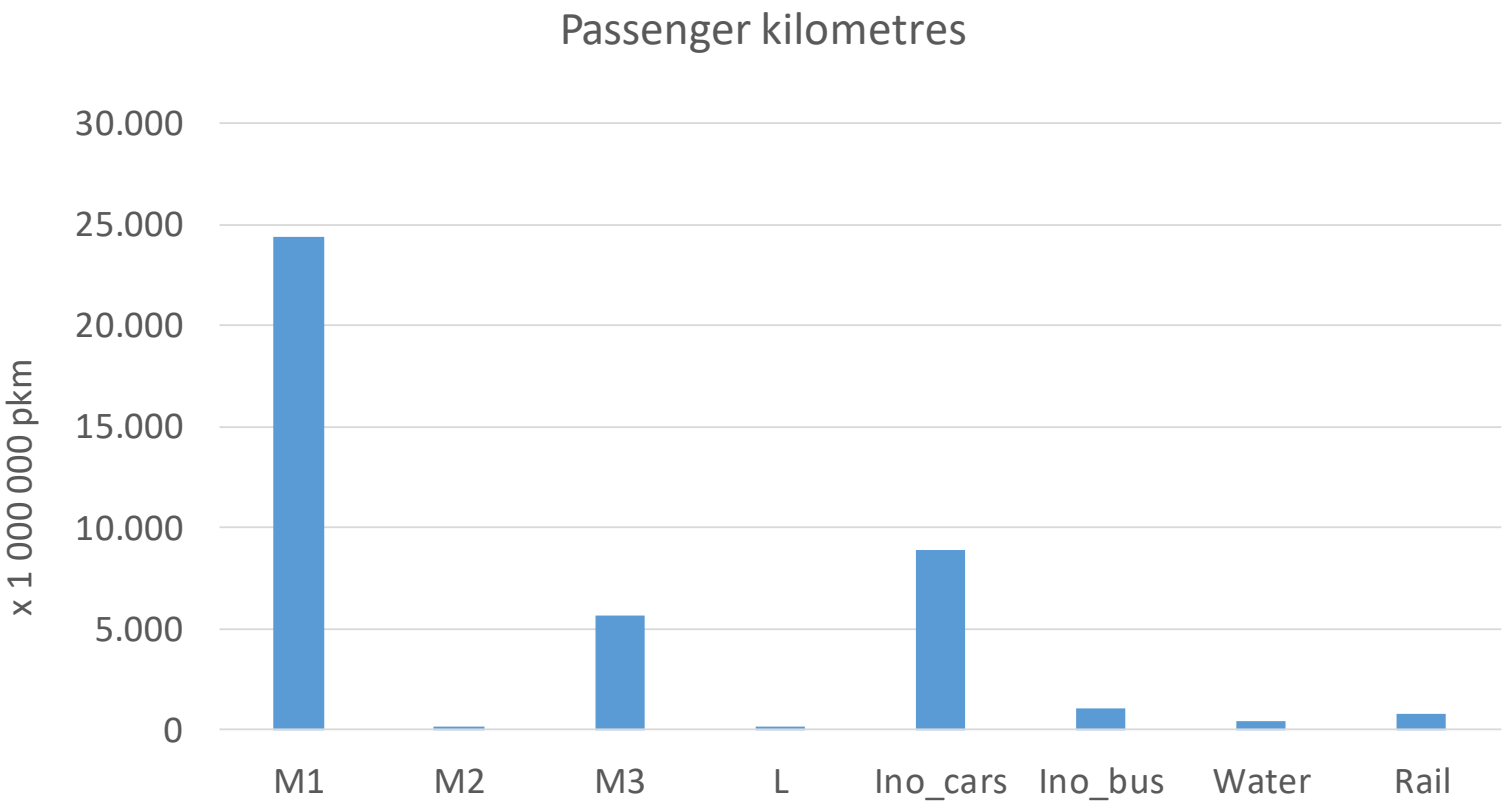
Balance of passenger kilometers



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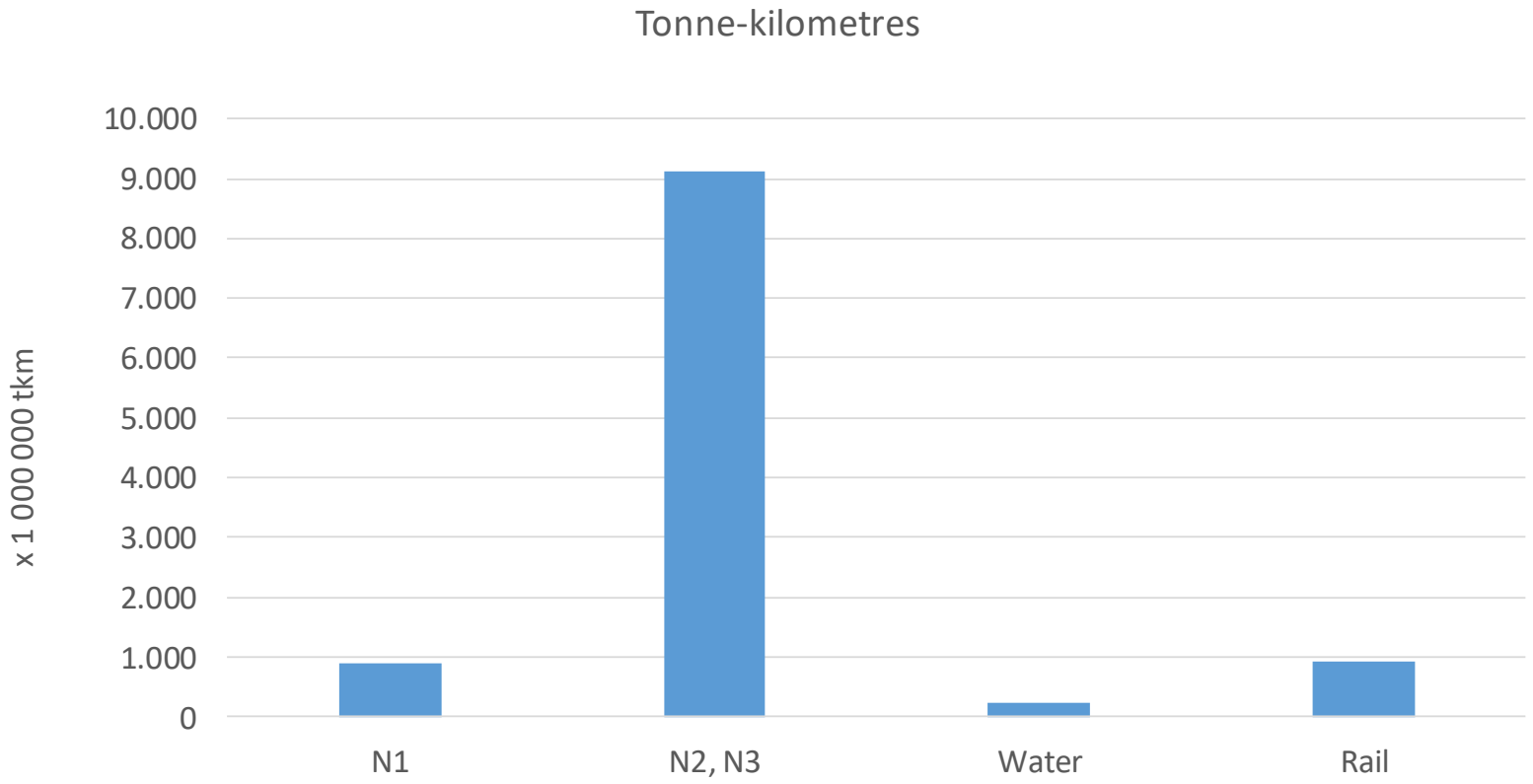
Balance of tonne-kilometres



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Reports | Table | Chart

EEI TRANSPORT

Other: PRODUCT/FLOW - Fuel intensity (litres/100 vkm) | ENDU

COUNTRY / TIME	Australia	Austria	Finland	France	Italy	Japan	Korea
2010	11.09	7.50	6.70	7.13	5.56	8.19	7.76
2011	11.03	7.43	6.60	6.97	5.52	8.24	7.82
2012	10.98	7.37	6.69	6.84	5.25	8.03	7.90
2013	10.76	7.34	6.66	6.66	5.18	7.63	8.30
2014	10.62	7.30	6.59	6.61	5.16	7.39	7.90
2015	10.60	7.26	6.66	6.58	5.04	7.33	7.99
2016	10.71	7.25	6.66	6.45	4.90	7.18	8.33
2017	10.32	7.22	6.59	6.46	4.71	7.01	8.19
2018	10.27	7.38	6.53	6.37	4.77	6.80	8.14
2019	10.24	7.35	6.44	6.35	4.75	6.63	8.29
2020	10.18	..	6.22	6.30	4.53	6.65	7.92

Reports | Table | Chart

EEI TRANSPORT

Other: PRODUCT/FLOW - Passenger-kilometres energy intensity (MJ/pkm)

COUNTRY / TIME	Australia	Austria	Finland	France	Italy	Japan	Korea
2010	2.33	2.14	1.41	1.48	1.20	2.22	..
2011	2.32	2.12	1.36	1.45	1.23	2.21	2.28
2012	2.31	2.11	1.36	1.43	1.33	2.16	2.31
2013	2.26	2.11	1.37	1.39	1.20	2.06	2.38
2014	2.24	2.10	1.37	1.39	1.24	2.01	2.32
2015	2.23	2.10	1.35	1.38	1.12	1.99	2.32
2016	2.26	2.10	1.35	1.36	1.04	1.95	2.51
2017	2.18	2.09	1.33	1.36	0.89	1.90	2.48
2018	2.16	2.14	1.32	1.34	0.99	1.84	2.48
2019	2.15	2.14	1.30	1.34	1.01	1.79	2.50
2020	2.14	..	1.26	1.34	1.16	1.82	2.49

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Conclusions

- Transport sector is the most complex sector for calculating indicators;
- Each transport mode requires specific modelling techniques and data sets;
- Development of the transport model can be based on the certain assumptions which are used for the purpose of the completion of modelling processes and analysis of sensitivities of specific indicators in the model
- Assumptions can give information how to improve data collection and to what new datasets should be given priority.

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Exercise

ANALYSIS AND MODELLING OF TRANSPORTATION INDICATORS IN ONE FAMILY – „SCHMIDT" FAMILY

Exercise: Calculation of transport indicators in personal cars

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CONCLUSIONS

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