THE ESTIMATION OF CARBON DIOXIDE (CO_2) EMISSIONS FROM THE TRANSPORT SECTOR IN MALAYSIA (2000 – 2020)

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ASIA-PACIFIC INTEGRATED MODEL

- Large scale computer simulation model developed at Japan's National Institute for Environmental Studies
- Its main goal: To assess policy options for stabilizing global climate, particularly in the Asia-Pacific region, from the perspectives of reducing GHG emissions and avoiding the impacts of climate change

The study looks at

1) Energy consumption patterns, and
2) projections from 2000 to 2020,

for the Transport sector (road users) in Malaysia

STEPS TAKEN IN PREPARATION OF DATABASE

Determining the Base Year, End Year and Discount Rate

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Selection of Sectors and Services

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Estimation of Energy Data

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Classification and Definition of Technology Systems

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Estimation of Energy Device Data

↓

Projection of Service Demands

- Base year chosen: 2000
- End year chosen: 2020
- Discount rate: 10%

5 types of services were chosen comprising exclusively road transportation

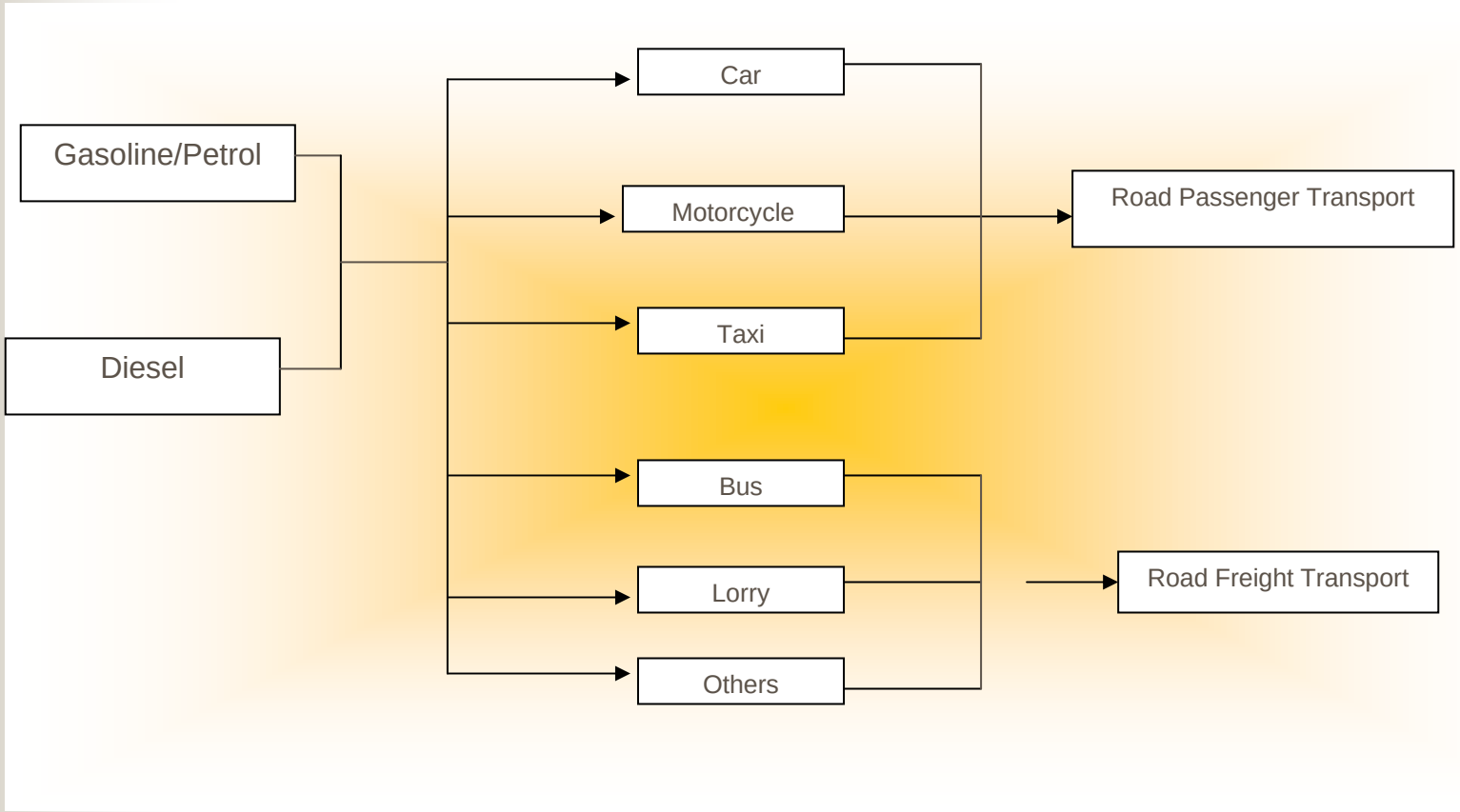
Sector and Final Service	Service Unit
Transportation-Passengers	
Car **Motorcycle** **Taxi** **Bus**	1000 person. kilometer (p.km) 1000 person. kilometer (p.km) 1000 person. kilometre (p.km) 1000 person. kilometre (p.km)
Transportation-Freight	
Lorry	1000 person. kilometre (p.km)

Energy Prices in AIM-Malaysia

Product	Unit	Value
Natural gas – Power plant	RM/mmbtu	6.40
LPG	RM/kg	1.28
*MOGAS – 97RON**	RM/liter	1.20
*MOGAS – 92 RON**	RM/liter	1.16
*Diesel – Transport**	RM/liter	0.701
Diesel - Industry	RM/liter	0.50 ~ 0.70
Diesel – Power Generation	RM/liter	0.30 ~ 0.60
Kerosene	RM/liter	0.65 ~ 0.70
Fuel Oil	RM/ liter	0.57 ~ 0.70
Coal	RM/tonne	~ 130
Jet fuel	RM/liter	0.70 ~ 0.90
Naphtha	RM/liter	0. 50 ~ 0.60
*NGV**	RM/liter	0.60

Emission Factors in AIM-Malaysia

Energy Name	*CO_2 Emission Factor ($kg\text{-}CO_2/GJ$)*
Natural gas	55.82
LNG	62.44
Crude oil	72.6
Others	73.33
Aviation gas	73.33
LPG	62.44
Motor Petrol	68.61
ATF	71.15
Kerosene	71.15
Diesel oil	73.33
Fuel oil	21.1
Refinery gas	73.33
Coal & Coke	99.83



Technology System in Road Transport Sector

An example of estimating Energy Device Data in the Transport Sector in AIM-Malaysia

	Passenger vehicle (Car)	*Freight vehicle (Lorry)*
Data from published sources		
A. Average km-travel per year (10^3 km/yr)	19.32	48.3
B. Stock number	4,145,982	665,284
C. Total energy consumption (1000 t)	5058	6672.8
D. Fuel efficiency (km/kg)	15.84	10.43
E. Price (Fixed Cost)	US$ 19,737	US$ 23,684
F. NO_x emission (kg NO_2/km)	10.3	52
Estimation used in AIM-Malaysia		
G. Average number of persons	2	2
H. Specific Energy Input (GJ/yr/d.u.)	53.75	196.79
I. Specific Service Output (s.u./yr/d.u.)	38.64	96.6

A,C,D,F,G: Department of Environment, Malaysia B: Department of Transport, Malaysia
H: A*D* Calorific Value*Conversion Factor I: A*G/1000

Service Demand in Transport Sector

- Projection of transportation ≡ annual percentage increase of vehicle population = 8%

- SRVo = NVo * x

  where,

  SRVo = Service demand in time period

  NVo = Number of vehicles in time period

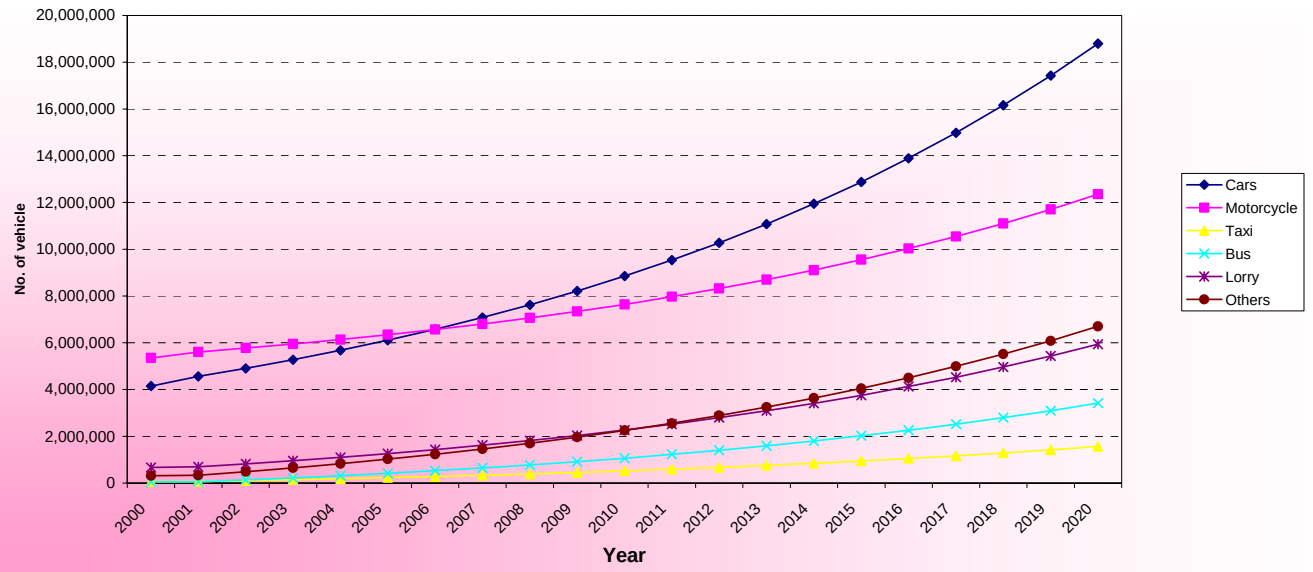
  x = Average km travel per year (10^3 km/yr)

Breakdown in Vehicle Population

- Passenger cars: 38%
- Motorcycles: 18%
- Taxis: 4%
- Buses: 9%
- Lorries: 14%
- Others: 17%
- Overall yearly increase: 8%

Projected Vehicle Population in Malaysia (2000 - 2020)

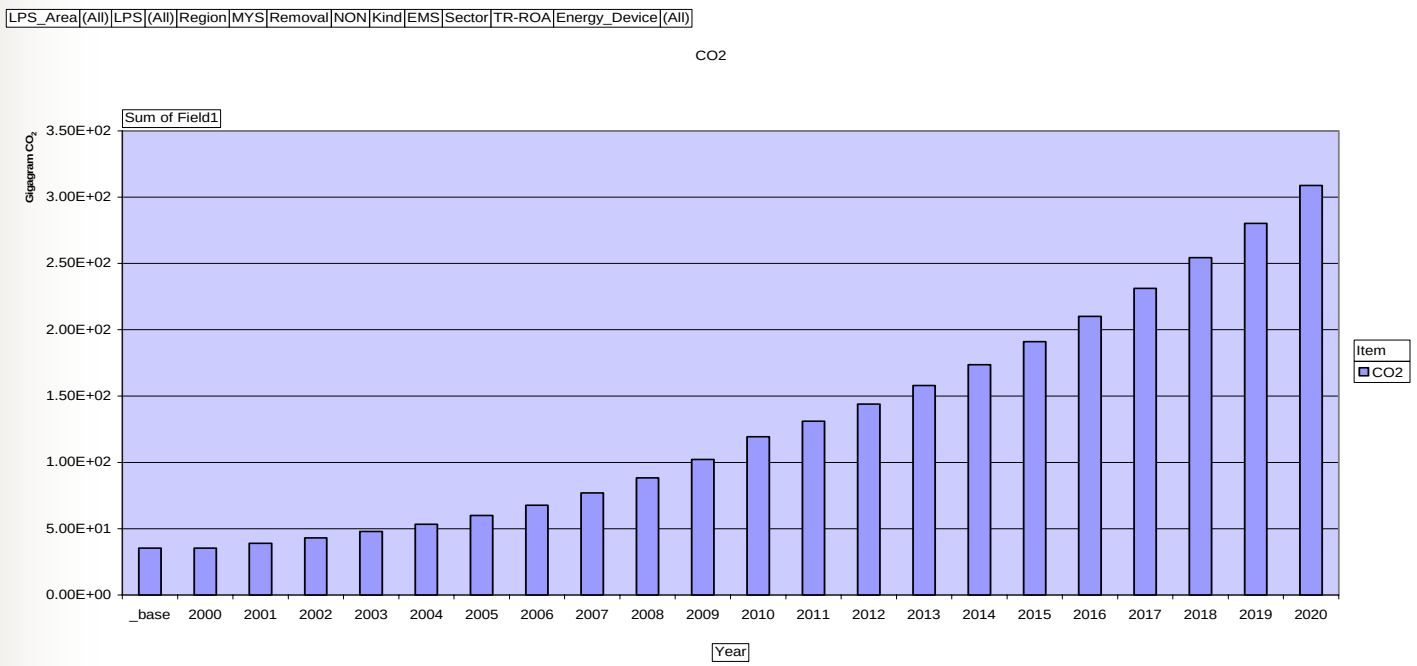
	Cars	Motorcycle	Taxi	Bus	Lorry	Other	Total
2000	4,145,982	5,356,604	66,585	48,662	665,284	315,687	10,598,804
2001	4,557,992	5,609,351	66,565	49,771	689,668	329,198	11,302,545
2002	4,901,590	5,772,108	102,733	131,149	816,257	482,913	12,206,750
2003	5,272,675	5,947,885	141,795	219,038	952,972	648,925	13,183,290
2004	5,673,447	6,137,724	183,981	313,957	1,100,625	828,218	14,237,952
2005	6,106,280	6,342,751	229,543	416,471	1,260,090	1,021,854	15,376,989
2006	6,573,741	6,564,179	278,749	527,185	1,432,312	1,230,981	16,607,147
2007	7,078,598	6,803,322	331,892	646,756	1,618,312	1,456,838	17,935,718
2008	7,623,844	7,061,597	389,286	775,894	1,819,193	1,700,764	19,370,578
2009	8,212,710	7,340,533	451,272	915,362	2,036,143	1,964,204	20,920,224
2010	8,848,648	7,641,784	518,217	1,065,987	2,270,449	2,248,719	22,593,841
2011	9,535,537	7,967,135	590,517	1,228,663	2,523,500	2,555,995	24,401,347
2012	10,277,338	8,318,514	668,601	1,404,353	2,796,795	2,887,853	26,353,455
2013	11,078,483	8,698,004	752,932	1,594,098	3,091,954	3,246,260	28,461,731
2014	11,943,720	9,107,853	844,010	1,799,023	3,410,726	3,633,340	30,738,670
2015	12,878,176	9,550,490	942,374	2,020,342	3,754,999	4,051,386	33,197,764
2016	13,887,388	10,028,538	1,048,607	2,259,366	4,126,814	4,502,876	35,853,585
2017	14,977,337	10,544,830	1,163,338	2,517,512	4,528,374	4,990,484	38,721,872
2018	16,154,482	11,102,425	1,287,249	2,796,310	4,962,059	5,517,103	41,819,622
2019	17,425,799	11,704,628	1,421,072	3,097,411	5,430,439	6,085,850	45,165,192
2020	18,798,821	12,355,007	1,565,601	3,422,600	5,936,289	6,700,097	48,778,407



Projected Vehicle Population in Malaysia (2000-2020)

Total CO_2 Emissions from the Transport Sector in Malaysia (2000-2020) – Business-as-Usual (BAU)

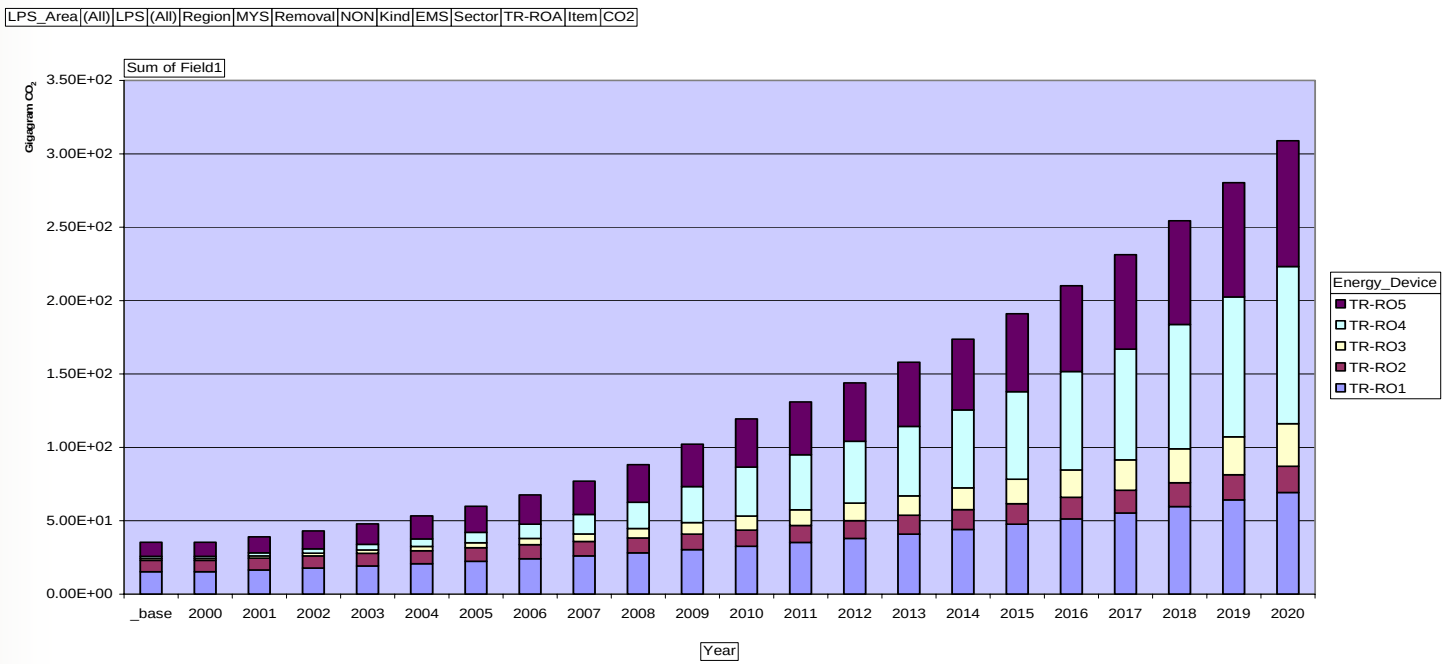
Year	CO_2 Emission (Gram)
_base	35,393,972,428
2000	35,393,972,428
2001	38,962,396,048
2002	43,062,233,003
2003	47,809,166,681
2004	53,351,598,750
2005	59,881,222,427
2006	67,647,220,989
2007	76,975,367,476
2008	88,293,756,256
2009	102,167,514,785
2010	119,345,683,321
2011	130,990,378,607
2012	143,836,023,763
2013	158,011,615,893
2014	173,660,430,375
2015	190,941,637,264
2016	210,032,103,842
2017	231,128,405,055
2018	254,449,066,105
2019	280,237,064,364
2020	308,762,620,952
Grand Total	**2,850,333,450,812**



Total CO_2 Emissions from the Transport Sector in Malaysia (2000-2020) - Business-as-Usual (BAU)

Projected CO_2 Emissions by Vehicle Type in Malaysia (2000-2020) (gram) – Business-as-Usual (BAU)

	TR-RO1	TR-RO2	TR-RO3	TR-RO4	TR-RO5	Grand Total
Base	15,289,500,595	7,754,600,269	1,227,893,705	1,521,523,450	9,600,454,409	35,393,972,428
2000	15,289500595	7,754,600,269	1,227,893,705	1,521,523,450	9,600,454,409	35,393,972,428
2001	16,493,713,069	8,035,075,052	1,507,558,805	2,071,738,189	10,854,310,934	38,962,396,048
2002	17,792,770,216	8,325,694,277	1,850,920,434	2,820,922,099	12,271,925,976	43,062,233,003
2003	19,194,142,074	8,626,824,859	2,272,486,117	3,841,026,599	13,874,687,033	47,809,166,681
2004	20,705,887,024	8,938,846,980	2,790,067,609	5,230,022,245	15,686,774,891	53,351,598,750
2005	22,336,698,135	9,262,154,575	3,425,533,475	7,121,307,803	17,735,528,440	59,881,222,427
2006	24,095,953,145	9,597,155,826	4,205,733,061	9,696,521,820	20,051,857,137	67,647,220,989
2007	25,993,768,392	9,944,273,678	5,163,630,923	13,202,987,150	22,670,707,333	76,975,367,476
2008	28,041,056,985	10,303,946,375	6,339,699,625	17,977,463,765	25,631,589,505	88,293,756,256
2009	30,249,591,554	10,676,628,012	7,783,629,764	24,478,491,100	28,979,174,356	102,167,514,785
2010	32,632,071,954	11,062,789,105	9,556,429,464	33,330,426,046	32,763,966,752	119,345,683,321
2011	35,185,994,754	11,607,252,871	10,673,642,465	37,454,263,928	36,069,224,589	130,990,378,607
2012	37,939,798,263	12,178,512,845	11,921,465,427	42,088,327,479	39,707,919,749	143,836,023,763
2013	40,909,125,983	12,777,887,822	13,315,167,563	47,295,744,841	43,713,689,684	158,011,615,893
2014	44,110,845,742	13,406,761,505	14,871,803,162	53,147,454,748	48,123,565,219	173,660,430,375
2015	47,563,145,517	14,066,585,695	16,610,420,277	59,723,172,891	52,978,312,884	190,941,637,264
2016	51,285,636,751	14,758,883,645	18,552,293,813	67,112,477,861	58,322,811,772	210,032,103,842
2017	55,299,465,759	15,485,253,578	20,721,185,857	75,416,031,444	64,206,468,416	231,128,405,055
2018	59,627,433,858	16,247,372,371	23,143,636,450	84,746,949,898	70,683,673,528	254,449,066,105
2019	64,294,126,891	17,046,999,433	25,849,288,348	95,232,344,893	77,814,304,799	280,237,064,364
2020	69,326,054,891	17,885,980,763	28,871,249,751	107,015,055,111	85,664,280,436	308,762,620,952
	773,656,282,147	255,744,079,804	231,881,620,800	792,045,776,808	797,005,682,252	2,850,333,450,812



Projected CO_2 Emissions by Vehicle Type in Malaysia (2000-2020) – Business-as-Usual (BAU)

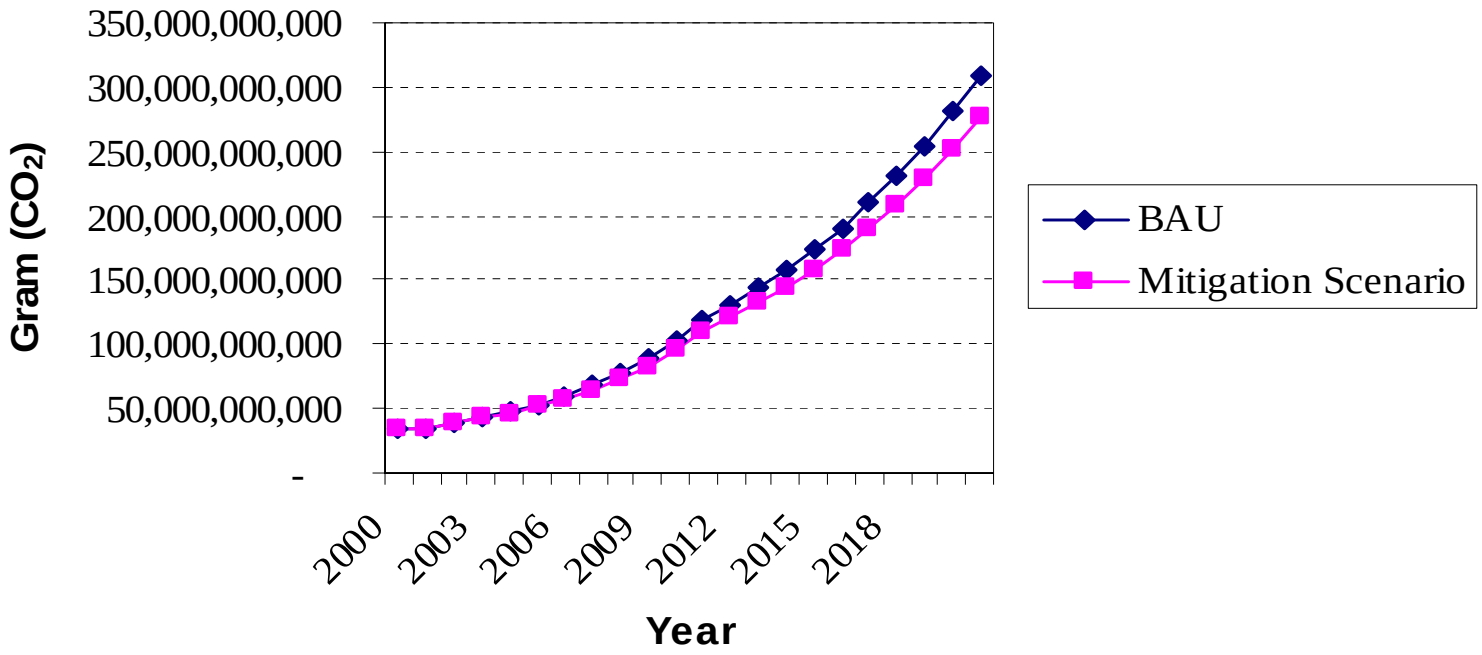
Mitigation Measures

- Fuel Switching – natural gas (cars and taxis)
  - biodiesel (lorries and buses)

  Apply to 50% of vehicle population by 2005, and 100% by 2020
- Public transport
- Non-motorised transport
- No mitigation option for motorcycles

Total CO_2 Emissions from the Transport Sector (BAU vs. Mitigation Scenario)

Year	BAU	Mitigation Scenario
_base	35,393,972,428	35,393,972,428
2000	35,393,972,428	35,393,972,428
2001	38,962,396,048	38,840,074,566
2002	43,062,233,003	42,790,331,857
2003	47,809,166,681	47,354,299,406
2004	53,351,598,750	52,672,511,686
2005	59,881,222,427	58,926,456,184
2006	67,647,220,989	66,136,065,340
2007	76,975,367,476	74,766,126,381
2008	88,293,756,256	85,203,565,677
2009	102,167,514,785	97,957,981,272
2010	119,345,683,321	113,703,005,985
2011	130,990,378,607	121,028,235,057
2012	143,836,023,763	132,421,482,853
2013	158,011,615,893	144,956,127,040
2014	173,660,430,375	158,751,908,754
2015	190,941,637,264	173,941,553,352
2016	210,032,103,842	190,672,211,752
2017	231,128,405,055	209,107,064,452
2018	254,449,066,105	229,427,106,803
2019	280,237,064,364	251,833,136,257
2020	308,762,620,952	276,547,964,704
Grand Total	**2,850,333,450,812**	**2,622,453,046,362**



Total CO_2 Emissions from the Transport Sector (BAU vs. Mitigation Scenario)

CO_2 Emissions (gigagrams)

	2000	*2020*
BAU	35	309
MITIGATION SCENARIO	35	277

CONCLUSION

- Corresponding decrease is moderate (32 gigagrams)
- Technological approach alone is insufficient
- Has to be complemented with non-technological approaches
- Drastic decrease in vehicle population – ideal solution?