

Climate Change

5. TRANSPORTATION SECTOR

5.1 INTRODUCTION

The transportation sector, world wide, still contributes around 70% of air pollution. The pollutants include, amongst others, carbon dioxide, hydrocarbons, and oxides of nitrogen that contribute to the greenhouse phenomenon.

Lebanon's transportation sector constitutes a fleet of over one million registered vehicles and can be characterized as being relatively old and poorly maintained. Moreover, the car ownership rate in Lebanon (3 persons for every car) is amongst the highest in the world. In the baseline and mitigation assessment, the data used in the comprehensive evaluation of national, social and economic development frameworks for climate change mitigation process included base year statistics as well as common data for short- and long- term projections.

5.2 BASE YEAR CONDITIONS

Its poor status and the lack of a regular vehicle inspection could characterize the Lebanese transport sector in 1994. The cumulative total of vehicles registered in Lebanon reached close to 1.4 million at the end of 1996, however, the actual number may not exceed 1 million vehicles. The average age of private vehicles is around 14 years.

The number of red- plat vehicles has undergone a significant change from around 10 thousand vehicles in 1994 up to around 32 thousands. Two bus services are operated, one publicly owned and one privately owned, the latter being more efficient. This sector has witnessed a significant improvement in the bus fleet size but with a disproportionate increase in ridership.

In the railways division, studies have been conducted for the rehabilitation and upgrading of the 170 km of railway along the coast. However, in light of the concerns raised about the potential impact of such an upgraded railway on the coastal area, the feasibility of an alternative alignment is being considered.

5.3 BASELINE SCENARIO PROJECTION

Fuel prices are expected to keep fluctuating around \$16/barrel for crude oil. In Lebanon, prices of fuel used for transport have been increased due to additional taxation. These increases, however, had a small impact on fuel consumption due to the lack of alternative means for transport and due to low fuel prices compared to other countries and compared to the average income.

Statistics on imported fuel for transport indicate that the amount of fuel will be slightly dropping in the short term due to the improvement in the status of the fleet caused by the ban on import of cars older than 8 years.

In the baseline scenario, it is assumed that the number of vehicles will have an annual

increase of around 1.5%. The fleet condition is expected to improve so that by year 2005, the average age of the fleet will drop to around 10-12 years compared to the 14-years average of 1994. Transport management would eventually lead to some consumption reduction. Inside GBA, however, most of the measures are within the scope of traffic control rather than traffic jams reduction.

In providing short- and long- term projections, the following factors are taken into consideration:

- Private cars: 1.5% annual growth.
- Taxis and minibuses: 30,000 by 1997 and an annual increase of 1% for later years.
- Buses: 4000 by 1996, and 1% increase from then on.
- Trucks and others: 96000 by 1996, and 1% annual increase from then on.

The annual distance travelled is expected to increase to 16000 Km by 2005, and to 18000 Km by 2040. Moreover, the consumption rate for all vehicles is expected to drop by 10% by year 2005 due to the drop the fleet's average age. The projection of the demand for gasoline, diesel, and jet fuel is shown in Fig.10.

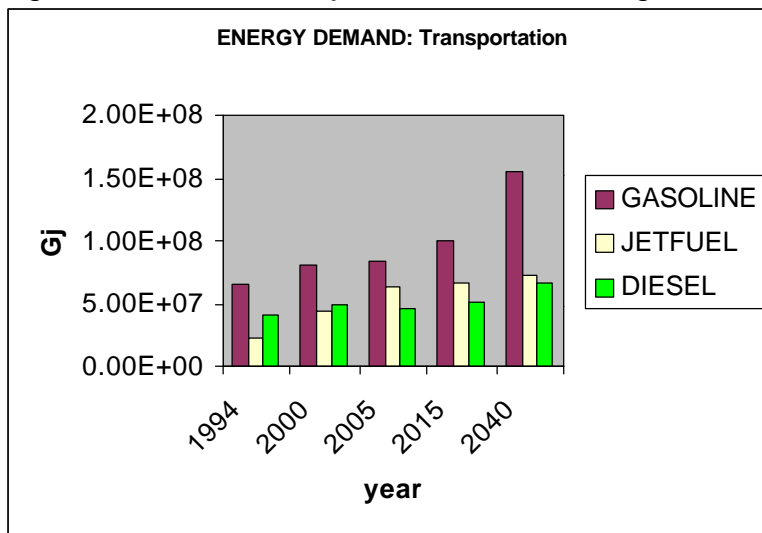


Fig.10 Transport fuel projection in the base line scenario.

The rehabilitation and extension project of Beirut International Airport would increase the capacity to around 6 million passengers annually. Plans are being developed to use the airport as a center for delivery and distribution of air cargo, served by feeder activity. For seaport and marinas activities, it is assumed that fuel consumed for sea transport is restricted to that used by local marinas and sports clubs. In the baseline scenario and in the absence of any statistics or plans, the data are set taking into consideration the new marina projects being planned and built along the Lebanese coast.

Table 17. Transport data					
Number of Vehicles					
Device	1994	2000	2005	2015	2040
CARS & JEEPS	914000	999000	1077000	1249000	1813000
TAXIS & MICROBUSES	9000	30909	32486	35884	46019
BIG BUSES	4000	4566	4799	5301	6798
TRUCKS & OTHERS	85000	99846	104939	115918	148657
Number of boats					
SMALL BOATS	280	738	1200	1440	2400
Number of Flights					
PASSANGER JETPLANES	19450	38878	61220	63791	70220
FREIGHT JETPLANES	1500	2517	4000	4200	4700

Table 18: Consumption rates in the base line projection

Vehicle Type	Consumption (Gj/vehicle) = (Gj/veh/km) * (km)				
	1994	2000	2005	2015	2040
CARS & JEEPS	70.065	75.525	72.066	74.638	81.075
TAXIS & MICROBUSES	202.409	202.409	182.168	182.168	182.168
BIG BUSES	369.750	369.750	332.775	332.775	332.775
TRUCKS & OTHERS	475.393	475.393	427.854	427.854	427.854
ELEC-GASO-VEH.	35.032	37.762	36.033	37.319	40.537
ELEC.TRAINS	12600	12600	12600	12600	12600
Consumption (Gj /flight)					
P-JETPLANES	1080	1080	972	972	972
F-JETPLANES	1080	1080	972	972	972
Consumption (Gj / boat)					
SMALL BOATS	36.975	36.975	33.278	33.278	33.278

A summary of the data used for the baseline scenario is shown in Table 17. Table 18 presents the consumption rate of various elements of the transportation sector.

5.4 CONCLUDING REMARKS ON BASELINE CONDITIONS

Gasoline will still be the major source of fuel for the transport sector and consequently, transport sector in Lebanon will still be regarded as the major source of greenhouse gases, namely carbon dioxide. The annual distance traveled would increase from 14000 km in 1994 only to 18000 km by 2040. The increase in the number of cars in accordance with the population growth would lead to a fleet size of 1.8 vehicles in 2040, compared to 0.914 million in 1994. The Lebanese fleet will be modernized to a certain extent, leading to consumption and emission reductions. The overall result is almost a doubling in the amount of GHG emitted, from around 4160 tons of CO₂ in 1994 up to 9150 tons in 2040. Buses used for private and public transport will increase due to Government intention, in the foreseeable future, to implement public transport in the entire country.

5.5 MITIGATION MEASURES

The transportation sector's emissions of GHG are in general related to the fuel type and its emission rate, the vehicle's technical status and its fuel consumption rate, and the distance traveled and time needed for every trip.

Therefore, the corresponding mitigation options are switching to fuel with lower emission rates, improving the technical status of the fleet, and improving the system's efficiency. Analysis and cost effectiveness for the mitigation options have been conducted for discount rates of 5, 10, and 15%.

5.5.1 Switching to Fuel with Lower Emission Rates

A major breakthrough has been recently reported in the development of hybrid electric vehicles (HEV) with a consumption rate almost 60% of that of equivalent conventional fuel-driven cars with a unit price almost 25% higher than the equivalent petrol-driven vehicle. In this aspect, two mitigation scenarios have been developed based on the spread of HEV in local fleet. The first scenario considers that by year 2015, HEV would constitute 1% of the local fleet, and this number is expected to double by year 2040. In the second scenario, a car registration fees waiver is considered leading to an HEV share increase between 5% and 10% in 2015 and double that value by 2040. The 10% boundary is to be considered since it gives more optimistic figures in terms of emission reductions.

5.5.2. Shift to Travel Modes with Lower Emissions

Measures applicable within this context include promoting public transport and freight railway systems. It is estimated that in 1994 there were 1.5 million motorized daily person trips in the GBA, subdivided among the various travel modes; private car (71%), taxi-service (17%), and buses (12%).

The number of motorized daily person trips in the GBA is expected to grow to 5 million by the year 2015. This significant growth in trip-making levels will not be matched by a similar growth in other parts of the country. To cope with this tremendous increase, two scenarios are considered. Scenario A, taken as base case, focuses on mass transport, and includes a significant heavy mass transit component, namely rail. Scenario B represents a continuation of existing trends, and focuses on the intense use of the private auto through further development of the road network.

Adopting an aggressive mass transport scheme in GBA as in Scenario A results in a 67% modal share for small vehicles in 2015, almost a 20% reduction from the base case. Since almost one-half of the national small vehicles fleet operates in the GBA, the 20% reduction will translate into a 10% reduction in automobile-related trip making at the national level. In this case, it was considered that the annual growth rate for private autos will drop from 1.5% to 1% (2000-2004), and to 0.7% for the year 2005 and beyond. These rates would result in a car fleet in 2015 that is 10% less than the base case. However, the rising speed from 18 km/hr to 22 km/hr in GBA is translated into an increase in fuel efficiency by about 30 km/20 liters.

Lebanon, being a car-importing country has no direct control on the design of vehicles, but can set specifications and requirements on imported cars. A more realistic measure is to encourage the import of new cars to reduce the average age of the fleet leading to higher efficiencies and lower emissions.

5.6. MITIGATION SCENARIOS- COMPARATIVE ANALYSIS

The 3 scenarios adopted for the transportation sector are:

- Hybrid electric vehicles, referred to as HEV. In this scenario, and due to the absence of any incentives, it is expected that by year 2015 hybrid vehicles would constitute only 1% of the local fleet.
- Hybrid electric vehicles with incentive, referred to as HEV II. In this scenario, a car registration waiver, estimated at 10% of the car cost, is offered by the government. As a result, it is expected that by year 2015 hybrid vehicles would constitute 10% of the local fleet.
- Trains for freight services, referred to as ET. The cost of this mitigation scenario is considered to be the difference in total investment between scenarios A and B of the ET.

Scenario	Discount	Benefits	Costs	NPV	B/C	Levelized Cost (1994 \$/ton)		
	Rate	1994	1994	1994	Ratio	CO2	CO	N0x
HEV	5	975	990	-5.4	0.9848	40	120	3100
	10	261	265	-4	0.987	30	190	4880
	15	90.6	92.4	-1.8	0.988	20	100	2600
HEV II	5	9970	9840	130	1.01	- 86.58	-420	-10800
	10	2666	2629	37	1.01	-28.4	-136	-3550
	15	930	918	12	1.01	-26.8	-130	-3350
ET	5	12160	2890	9270	4.21	-390	-1860	-48380
	10	3063.48	981.3	2082.18	3.12	-300	-1450	-37720
	15	1045.92	438.96	606.97	2.38	-130	-600	-15620

The benefits- to- costs ratio (B/C) expresses the measure's feasibility. HEV deployment, with financial incentive, would lead to significant GHG reduction and savings in the long run. The 10% waiver in terms of registration fees would eventually lead to 4.67% drop in fuel consumption in 2015, and to around 10% drop by 2040.

The use of mass transit is the ultimate mitigation option. It leads to a relatively high benefit/cost ratio that varies from 2.4 up to 4.21 depending on the national discount rate.

Fig.11. Emission reduction and cost of applied scenarios.

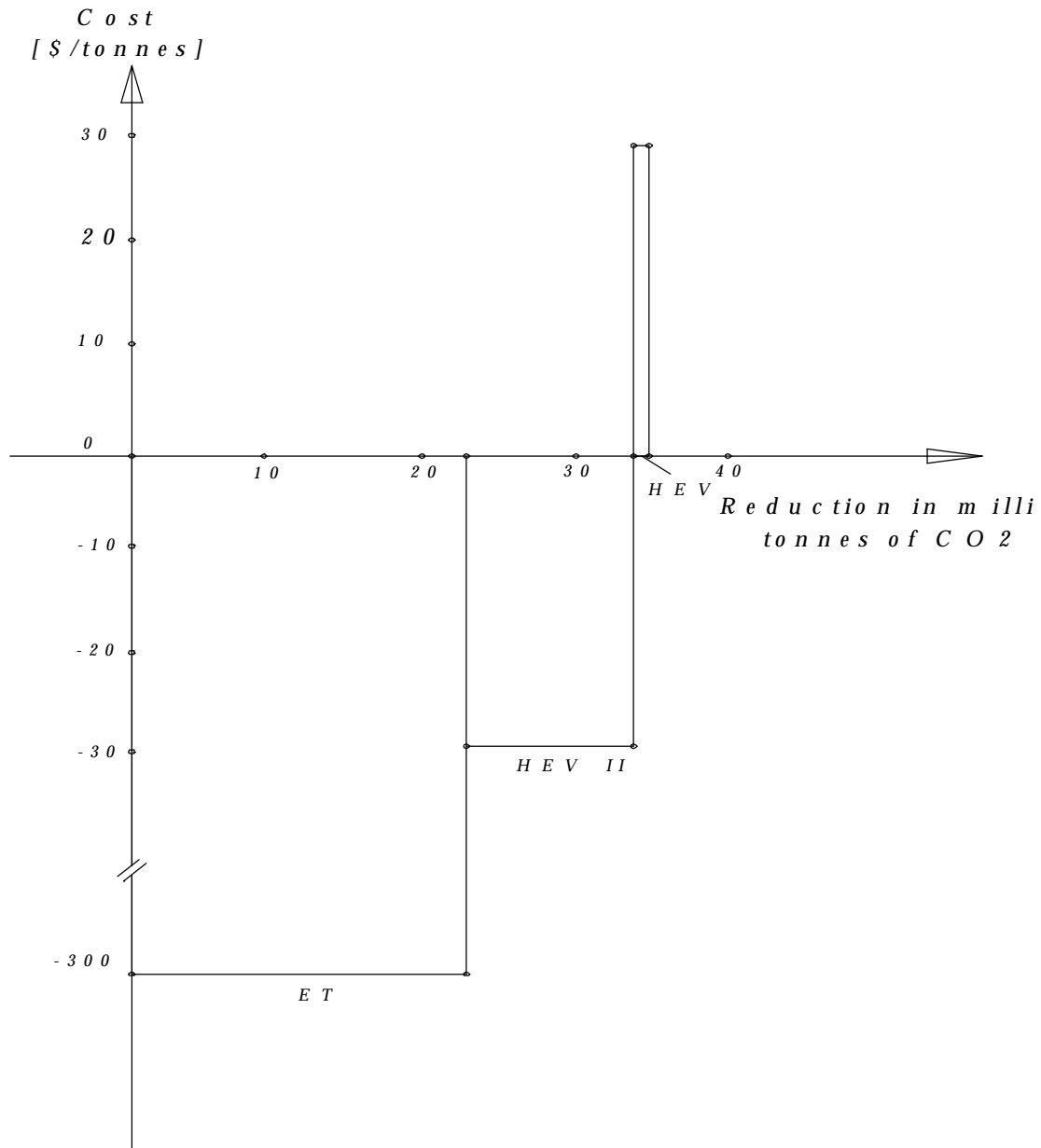


Fig.11 shows the reduction of carbon dioxide achieved by each of the three scenarios for discount rate of 10%. The negative cost values indicate that the corresponding scenario is profitable in the long run.

In air transport, realistic ideas include changes to promote and accelerate the deployment of fuel- efficient technologies in aircraft. The relevant costs are, however, still very difficult to estimate.

5.7 CONCLUDING REMARKS

Mitigation scenarios are conducted for measures that are applicable in Lebanon. The new vehicle technology of hybrid electric vehicle (HEV) with much lower GHG emission rate could have a consumption rate almost 60% of that of equivalent conventional fuel-driven car but with a unit price almost 25% more. Two scenarios with and without financial incentives have been developed. In the second scenario, car registration waiver is introduced by the government, and this is expected to increase the share of HEV to 10% of the imported cars by 2015 and again by twice this value by 2040. This scenario would lead to emission reduction rate is around 10% and would be profitable in the long run due to savings in fuel consumption.

Measures to shift towards travel modes with lower emissions include promoting public transport and freight railway systems. Rail freight systems have the greatest benefit-to-cost ratio and the greatest relative emissions reduction compared to the HEV options. Deployment of rail systems for freight is the most promising alternative in term of consumption and emissions reduction. Adopting a rail system of six lines results in a 67% modal share for small vehicles in 2015. This reduction is expected to translate into a 10% reduction in automobile-related trip making at the national level. The increase in speed on the GBA from 18 km/hr to 22 km/hr is translated into an increase in fuel efficiency and consumption rate close to 30 km/20 liters.

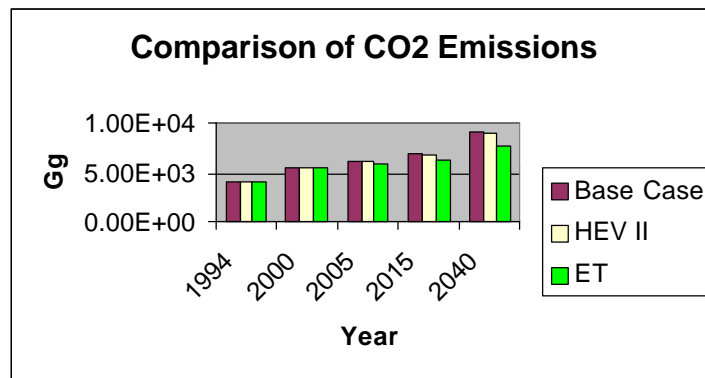


Fig.12 Comparison of CO₂ emissions

A comparison of the CO₂ emissions in the base line, the HEV with incentive, and the electric trains scenarios are illustrated in Fig. 12.