## Technology Fact Sheet for Mitigation

### I. Bus Technologies [i]

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| **Sector : Transport** | |
| **Subsector : Public transport technologies** | |
| **Technology characteristics** | |
| Introduction | Though diesel buses are still the most used bus technology worldwide, several bus technologies have made a breakthrough in public transport services, relying on different sort of fuels other than diesel. Among them alternative fuel buses operating on CNG, LNG and LPG, and electric driven buses.<br>In this document, 12-meter buses are assessed, using diesel, gasoline, alternative fuels and electricity (Figure 1).<br>  <br><br>Figure 1. 12-meter transit bus. |
| Technology characteristics | Bus public transport is a real medium to short-term solution to today's environmental and noise pollution issues in Lebanon, particularly when bus technologies are coupled to a well designed Transport Demand Management (TDM) system: particularly, the Bus Rapid Transit (BRT) system.<br>BRT system is a high-capacity transport system with dedicated lanes for bus transit. It consists of a systematic combination of infrastructure (busways, stations, terminals) with organized operations and intelligent technologies to provide a higher quality experience than possible with traditional bus operation. Main services enhancements are increasing the average velocity and ensuring matching the scheduled timetables.<br>BRT systems can make an important contribution to a sustainable urban transport system, particularly if combined to clean bus technologies. It is more energy efficient than passenger cars and conventional buses (per person-kilometer), due to the higher speeds and higher capacity buses. Thereby they contribute to the following aspects of sustainable development:<br>· Reduction of air pollution<br>· Reduction of GHG emissions<br>· Congestion reduction<br>· Increase in energy supply security, due to reduction of imported oil<br>· Social equality and poverty reduction by providing affordable high-quality transport with lower operating costs than passenger cars per passenger-kilometer<br>· Economic prosperity by reducing travel times and congestion<br>However, BRT systems face significant challenges in terms of investment costs, though they vary widely. Depending on the required capacity, urban context and complexity of |

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<tr><td></td><td>the project, BRT systems can be delivered for 1-15 million USD/km, with most existing BRTs in developing countries in the lower part of this range. These figures are substantially lower than those for rail-based systems, which cost approximately 50 million USD/km.</td></tr>
<tr><td>Endorsement by experts</td><td>· Public transport is endorsed by MOPWT.</td></tr>
<tr><td>Advantages</td><td>· Reduce total vehicle mileage<br>· Reduce congestion, energy consumption, incident and emissions<br>· Increase road capacity and speed</td></tr>
<tr><td>Disadvantages</td><td>· An effective public transport bus system requires dedicated lanes, particularly when implementing a BRT system (needed urban space)<br>· Need an optimized network to serve all regions in the city<br>· High government investment expense<br>· Customers are limited around scheduled timetables, and they have to expect delays if not well managed<br>· Average speed could be lower than passenger cars if not using dedicated lanes</td></tr>
<tr><td colspan="2">Capital costs</td></tr>
<tr><td>Additional cost to implement mitigation technology, compared to “business as usual”</td><td>According to a study realized by the Transport Union for Public Transport (UITP), the initial extra capital costs compared to a 12-meter diesel bus at 200000 Euros are summarized in table 1.<br>Table 1. Additional initial capital costs in Euros.
<table>
<tr><th></th><th>CNG</th><th>LPG</th><th>Diesel + CRT*</th><th>Diesel + SCRT**</th></tr>
<tr><td>Vehicle</td><td>40000</td><td>30000</td><td>5000-6000</td><td>10000</td></tr>
<tr><td>Filling station</td><td>0.3-0.6 MEuros</td><td>0.22 MEuros</td><td>-</td><td>-</td></tr>
<tr><td>Safety devices</td><td>0.03-1 MEuros</td><td>1 MEuros</td><td>-</td><td>-</td></tr>
<tr><td>Cleaning installations</td><td>-</td><td>-</td><td>25000</td><td>25000</td></tr>
<tr><td colspan="5">*CRT: Continuously Regenerating Technology. It reduces HC and PM by over 90% and CO by over 70%.<br>**SCRT: Selective Catalytic Reduction Technology. It is a four-way emission control system that reduces CO, HC, and PM by over 90% and NOx by 70%.</td></tr>
</table></td></tr>
<tr><td colspan="2">Development impacts, direct and indirect benefits</td></tr>
<tr><td>Cost benefits</td><td>Bus technologies present clear cost savings per passenger-kilometer comparing to passenger cars. Figures 2 and 3 highlight these savings in percent, by comparing to the average fuel cost of the Lebanese car fleet with 1 and 4 pass/veh. This assessment is done with different fuel prices, from Egypt, Greece, Turkey, France, Germany and USA.<br>· In average occupancy (15 pass/veh), Diesel and CNG buses present cost savings around 75-80% independently from the fuel price difference in the considered countries.<br>· These savings could reach 88% with 30 pass/veh, estimated for rush hours.<br>· As for passenger cars, savings could be considered only when the car is shared</td></tr>
</table>

by 4 passengers.

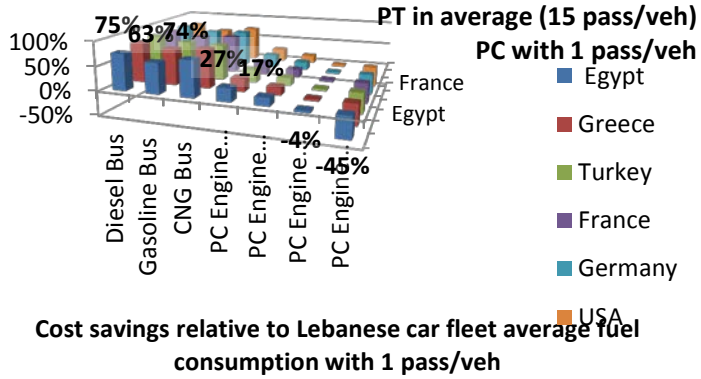


Figure 2. Cost savings of PT in average use (15 pass/veh) and PC (1 pass/Veh) relative to Lebanese car fleet average fuel cost with 1 pass/veh. The fuel price is estimated from Egypt, Greece, Turkey, France, Germany and USA database.

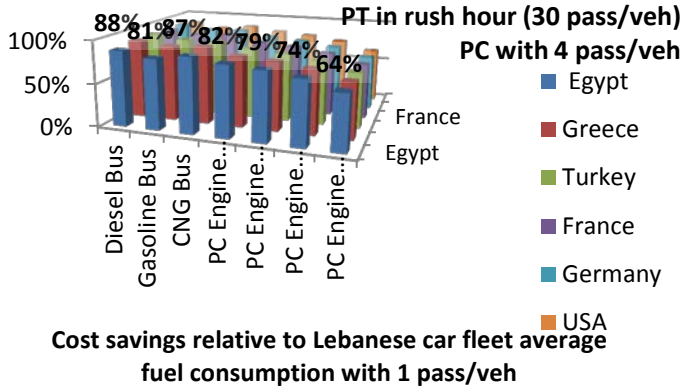


Figure 3. Cost savings of PT in rush hours (30 pass/veh) and shared PC (4 pass/Veh) relative to Lebanese car fleet average fuel consumption with 1 pass/veh. The fuel price is estimated from Egypt, Greece, Turkey, France, Germany and USA database.

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| Environmental benefits | The passenger-kilometer efficiency of bus technologies is higher than passenger cars, which is the main reason why public transport can lower the GHG and pollutant emissions of road traffic and reduce the total energy use of oil. Nevertheless, this efficiency differs largely with the type of fuel used and bus occupancy. Figures 2 and 3 illustrate the passenger-kilometer efficiency and CO2 emissions of different bus technologies as function of their occupancy. Results are compared to the average efficiency of the Lebanese car fleet (1950-2008), with 1, 1.5, 2 and 3 pass/veh.<br>· In Lebanon, passenger cars occupancy is estimated to be lower than 2. Therefore, diesel, gasoline, CNG and electric driven buses would present a better efficiency and lower CO2 emissions as their occupancy exceeds 10 to 15 pass/veh. |

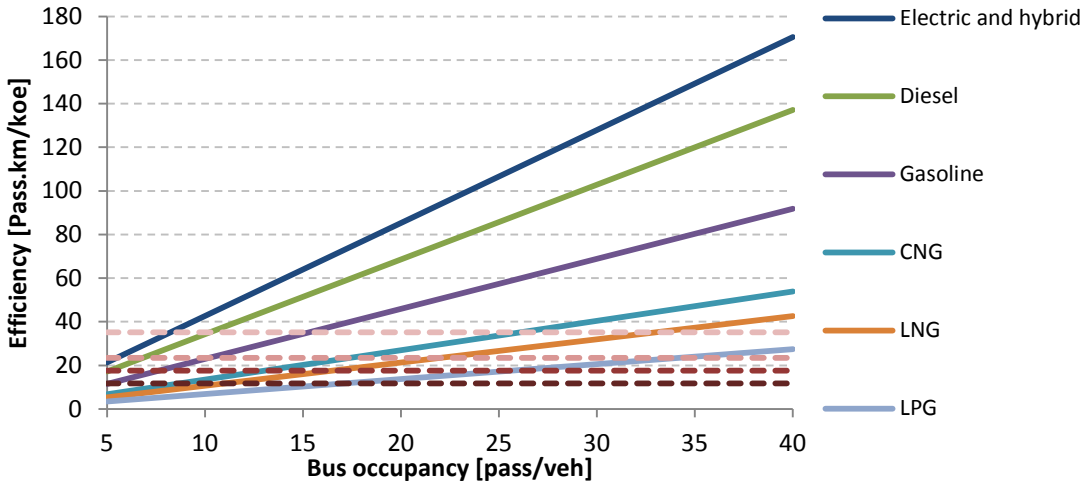


Figure 2. Efficiency of bus technologies as function of bus occupancy, compared to the Lebanese average PC efficiency, with 1, 1.5, 2 and 3 pass/veh.

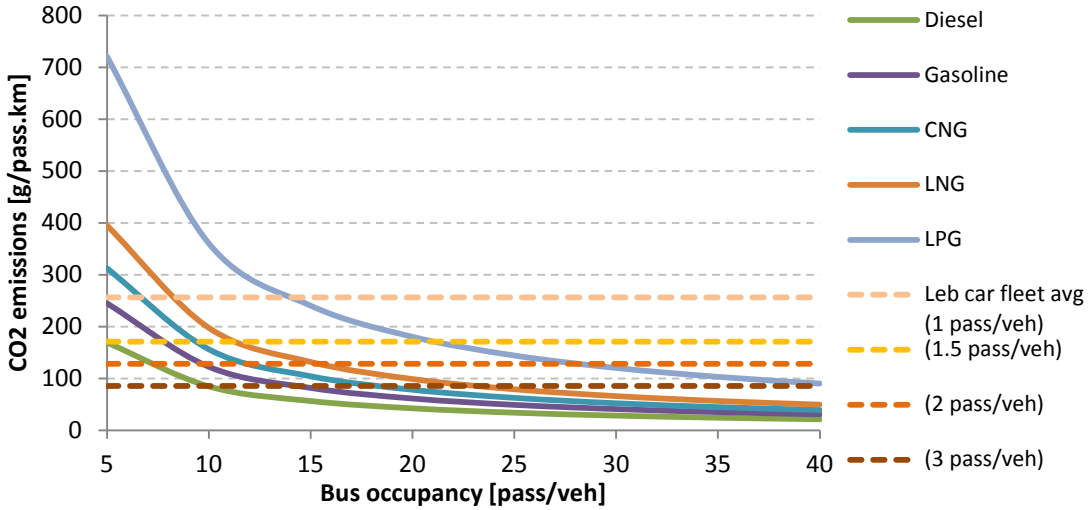


Figure 3. CO2 emissions of bus technologies as function of bus occupancy, compared to the Lebanese average PC CO2 emissions, with 1, 1.5, 2 and 3 pass/veh.

| **Local context** | |
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| Status | Collective transport in Lebanon consists of public and private bus transit. Unfortunately, no feedback from on-road public transport services is available to assess the efficiency, emissions and performance |

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<tr><td></td><td>of the system, except the below data published by CAS.<br><br>Public collective transport<br>Public collective transport is decreasing with time because there is no new investment to buy and to replace old buses. Thus lines are disappearing. Table 2 summarizes the situation of public collective transport in 2008, provided by CAS and based on Ministry of Transport, Office of Railways and Collective Transport data.<br><br>Table 2. Public collective transport in Lebanon in 2008.
<table>
<tr><th>Region</th><th>Average number of working buses</th><th>Total trips</th><th>Distance traveled (km)</th><th>Total passengers</th></tr>
<tr><td>Beirut and suburb</td><td>271</td><td>29001</td><td>1302201</td><td>1489596</td></tr>
<tr><td>Bekaa</td><td>29</td><td>2045</td><td>153976</td><td>107161</td></tr>
<tr><td>Tripoli and suburb</td><td>10</td><td>1125</td><td>53976</td><td>51662</td></tr>
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Private collective transport<br>Lebanese Commuting Company (LCC) provides CAS with statistics about private collective transport. In 2008, the number of lanes was 10. There was 52139 operational bus trips that cover 9025532 lanes-kilometers.</td></tr>
<tr><td>Timeframe</td><td>Short term implementation<br>Public transport bus technologies implementation could start immediately. However, BRT system need an adequate planning and could be implemented on the short to medium-terms.</td></tr>
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[i] **This fact sheet has been extracted from TNA Report – Technology Needs Assessment Reports For Climate Change Mitigation – Lebanon. You can access the complete report from the TNA project website http://tech-action.org/**