

# CLIMATE CHANGE AND ENVIRONMENT IN THE ARAB WORLD PROGRAM

## Sustainable Transport Series

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### Commuters' Behavior towards Upgraded Bus Services in Greater Beirut: Implications for Greenhouse Gas Emissions, Social Welfare and Transport Policy

#### Summary

Potential greenhouse gas (GHG) emissions reduction and social welfare gains can be achieved from upgrading the bus service in the Greater Beirut Area through a bundle of realistic bus service improvements in the short term. Such improvements will need to be comprehensive in scope and include both improvements in bus level of service attributes (access/egress time, headway, in-vehicle travel time, and number of transfers) and the provision of amenities, including air-conditioning and Wi-Fi. Moreover, such a service needs to be cheaply priced to achieve reasonably high levels of switching behavior and positive welfare gains.

#### Recommendations

By means of a richer behavioral representation of the mode switching process for a particular set of measures aimed at improving the bus service, a bundle of realistic bus service improvements in the short term is recommended, that will result in a reasonable shift to buses and measurable reduction in vehicular emissions.

- Such improvements will need to be comprehensive in scope and include:
  - » Improvements in bus service attributes (access/egress time, headway, in-vehicle travel time, and number of transfers)
  - » Improvement in provision of amenities, including sheltered stops, CCTV cameras in stops and buses, air conditioning, and Wi-Fi.
  - » Low prices to achieve reasonably high levels of switching behavior and positive welfare gains.
  - » Complementary actions are needed to promote the viability of any public transport solution, including but not restricted to:
    - \* supportive urban planning,
    - \* enforcement of traffic regulations,
    - \* parking restrictions and pricing,
    - \* technology improvements in the vehicle fleet
  - » This recommended bus service improvement scenario reinforces the point made by IBI Group and TEAM International (2009) that the purchase of new buses, adding more routes, or increasing service frequency without significant improvements to the level of service will not result in increased bus ridership.

The Climate Change and Environment in the Arab World Program aims to understand the climate change and environment policy process in the region and define the most appropriate policy recommendations by linking development in applied sciences on issues related to climate change and environment to social sciences.

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## Problem Statement and Key Messages

Accounting for 22% of total greenhouse gas (GHG) emissions, the transportation sector is one of the major drivers of climate change (IEA, 2012). In Lebanon, a developing country where car ownership rates are extremely high and public transportation is perceived to be unreliable and of low quality, vehicular emissions are a major contributor to air pollution and the air concentration of pollutants far exceeds air quality standards (MoE, et al., 2012). Yet a higher degree of public transport adoption would deliver improved air quality alongside other benefits. Upgrading the bus service in the Greater Beirut Area through a bundle of feasible bus service improvements, will result in a reasonable shift to buses and measurable reduction in vehicular emissions in the short-term. Such improvements will need to be comprehensive in scope and include both improvements in service level attributes (access/egress time, headway, in-vehicle travel time, and number of transfers) and the provision of amenities, including air-conditioning and Wi-Fi. Moreover, such a service needs to be cheaply priced to achieve reasonably high levels of switching behavior and positive welfare gains. A fare of LBP 1,000 (around \$0.67), together with a good level of comfort and 50% reduction in additional bus in-vehicle time, out-of-vehicle time, and transfers, would trigger 44% of commuters to switch to bus for commuting, resulting in \$24 million of welfare gains and a reduction in GHG emissions of 35,000, tCO<sub>2</sub>e/year (32% of car commuting emission). With a comprehensively overhauled bus service, it is expected that bus ridership would increase for commuting purposes at first, and once the habit for it is formed, for travel purposes other than commuting, hence dramatically broadening the scope of GHG emissions reduction.

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## Climate Change and Transportation

Climate change is one of the most critical environmental challenges faced in the world today with threats on the ecosystem, food security, water resources and the overall economic stability.

The transport sector is a major contributor to GHG emissions with road transportation accounting for 80% of the overall emissions from the sector. Concerns over this major role in GHG emissions have led to studies on sustainable transportation modes, technologies, and behaviors and their environmental implications. This study focuses on the potential emissions reduction and social welfare gains resulting from improved bus services in Greater Beirut. The focus region represents the center of Lebanon, a developing country, where car ownership is extremely high (1.55 million vehicles; about one car for every three persons), the average occupancy rate is low (1.7), and the automobile travel demand is increasing (projected to be 5 million automobile passenger trips in 2015). Along with the fact that public transportation is perceived to be unreliable and of low quality, the concentration of air pollutants exceeds by far air quality standards. A significant behavioral change would be required to promote a modal shift to public transportation and the attendant significant reductions in emissions with all its ramifications on air quality and GHG emissions. The bus service improvements tested in this study are realistic and easily applicable within the coming years.

## The Transportation Sector in Lebanon

The vehicle fleet in Lebanon consists of private cars, privately and publicly operated buses, minibuses, taxis, and jitneys (locally known as 'service'). Daily passenger trips in Greater Beirut amounted to about 2.8 million automobile trips in 2007 and are expected to grow to 5 million in 2015 (Ministry of Public Works and Transport, 2007). The current mode split of motorized trips in Greater Beirut is: 71% by private car, 19% by jitney and taxi, and 10% by buses and minibuses.

**Bus fares should be low and not exceed LBP 2,500.**

Besides the excessive number of private automobiles and the low occupancy rate, other factors that affect current mobility patterns in Greater Beirut are poor urban planning, unreliable public transportation system, cars being associated with social status, and the abundance of old and pre-owned cars and car purchase credit facilities. The public transportation sector is poorly organized due to lack of government planning and poor enforcement of traffic regulations. The number of privately owned mini-vans and small buses has increased three-fold from 1994 to 2005 and they function in the absence of regulated schedules or routes and are not restricted to one operational body.

Taking into consideration the situation mentioned above, the transportation sector in Lebanon is responsible for 19.5% of GHG emissions and around 93% of total carbon monoxide emissions in the country. Thus, the concentrations of particulates, ozone, and carbon monoxide in the air in Beirut are 2-4 times the international standards. The severity of the congestion and pollution problem arising from the transportation sector in Lebanon points to the urgency of reducing the reliance on the private car and inducing a substantial switch to public transportation for daily commuting. The Lebanese government has been planning to expand its bus fleet by adding 250 buses. The current study considers this option as a realistic and short term measure, and focuses on the needed bus service improvements that will decrease dependence on private vehicles and increase the use of public buses.

## Improvements in the Bus Service Will Lead to Mode Switching, Decrease in Greenhouse Gas Emissions, and Increase in General Welfare

The results of the study show that commuters give high importance to the quality of service provided since switching probabilities always increase when comfort attributes (sheltered stops, Wi-Fi, AC) are added. Level of service attributes including in-vehicle and out-of-vehicle travel time, bus frequency, bus fare, and transfers are also key factors affecting switching behavior. The in-vehicle travel time savings by car is estimated at around 35,000 LBP/hour while by bus it is around 12,000 LBP/hour.

Public transport policy-makers are justified in proposing a comprehensive upgrade of the bus service in Greater Beirut, in terms of both the level of bus service attributes (travel time and cost) and additional amenities, as this will ensure substantially, higher ridership and emissions reductions and lower traffic than a bus service focused solely on level of service attributes or service amenities. With the upgraded bus service and low bus fare (LBP 1,000), 44% of commuters will switch to using public buses thus causing a 39% reduction in trips and a 32% reduction in GHG emissions.

Considering the welfare implications (including savings in car expenses, additional costs of bus ridership, and net benefits from reduced GHG emissions), policy-makers should take into consideration several pivotal points. Bus fares should be low and not exceed LBP 2,500. For example, at a fare level of LBP 1,000, the total net benefit is at \$24 million.

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was inaugurated in 2006 to harness the policy-related research of AUB's internationally respected faculty and other scholars, in order to contribute positively to Arab policy-making and international relations. IFI is a neutral, dynamic, civil, and open space that brings together people representing all viewpoints in society. It aims to: raise the quality of public policy-related debate and decision-making in the Arab World and abroad; enhance the Arab World's input into international affairs; and, enrich the quality of interaction among scholars, officials and civil society actors in the Middle East and abroad.

Total net benefits decrease with an increase in bus fare and reach a negative value with a one-way fare over LBP 2,500. Thus, a bus system must be employed where comfort levels and time saving attributes are favorable and fares are low.

- A bus system with a high comfort level and a low fare causes a decrease of 35,000 tons of GHG emissions per year from commuting trips. As fares increase, the reduction in the amount of GHG emissions decreases to reach a negligible number.
- Bus services with low comfort and time saving attributes also had negligible effects on greenhouse gas emissions reduction even with a fare of LBP 1,000. Policy-makers should also consider security and technological aspects and amend them in the bus service since these attributes also played a major role in commuters' preferences.

In summary, the bus service provided should include different qualitative attributes in addition to improvement in level of service attributes to achieve its goal of commuters shifting to public transportation and reducing greenhouse gas emissions.

## Conclusions

With a comprehensively overhauled bus service, one would expect that bus ridership would increase for commuting purposes at first, but once the habit of using the bus is formed, citizens will start depending on buses for travel purposes other than commuting. Here the scope of GHG emissions reduction is no more confined to commuting emissions alone (which currently are in the region of 0.1 million tCO<sub>2</sub>e/year), but goes beyond to encompass the entirety of the 0.4 million tCO<sub>2</sub>e/year car GHG emissions.

Behavioral interventions themselves may be limited in their reach and need to be coupled with other measures, most notably technological innovations, in order to decrease the contribution of this sector to GHG emissions. Any single-minded policy focus on one facet at the expense of others will risk having meager returns to costly investments. Any policy that has GHG and an increase of social welfare in mind should consider technology advances in this sector. Hybrid cars and low emission fuels are examples of these advances that should be incorporated with improvement of the public transportation sector; in addition, these new advances will cause an increase in social welfare due to increased saving in fuel costs which may cause an even lower fare.



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