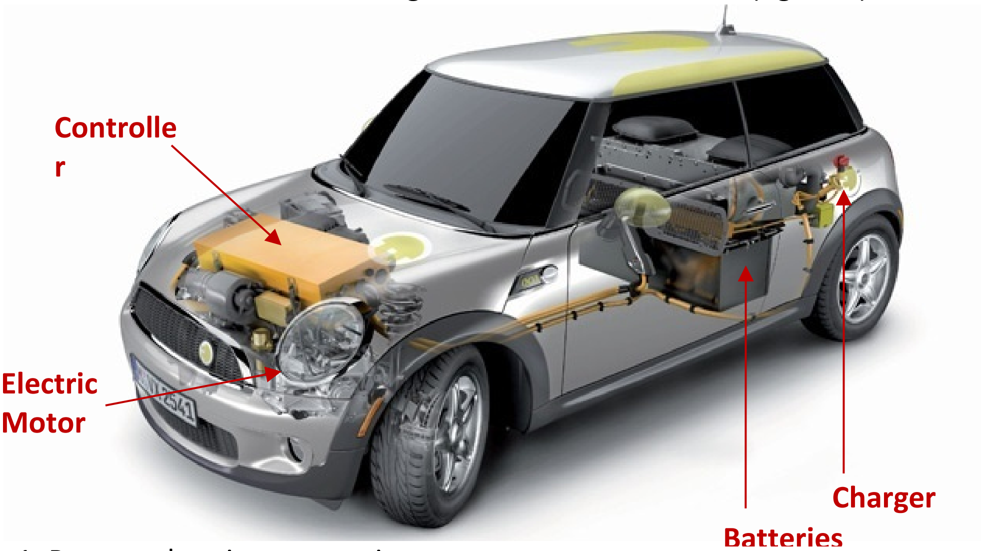
Technology Fact Sheet for Mitigation

N. Battery Electric Vehicles [i]

Sector : Transport	
Subsector : Advanced powertrains for passenger cars	
Technology characteristics	
Introduction	Battery Electric Vehicles (BEV) are propelled by an electric motor (or motors) powered by rechargeable battery packs. They derive all the power from the battery packs and thus have no internal combustion engine, fuel cell, or fuel tank (figure 1).  Figure 1. Battery electric powertrain
Technology characteristics	BEV is a real medium to long-term solution to today's environmental and noise pollution issues in cities. Technological innovations now make it possible to mass market an electric vehicle at reasonable cost. In addition, changes in vehicle use make electric cars ideal for the majority of trips, with 87% of Europeans currently driving less than 60 km a day. **Powertrain** There are three main technical differences between the powertrains of an ICE vehicle and a BEV: · The internal combustion engine is substituted by an electric motor · The electric motor is powered by a controller · The controller in turn is connected to rechargeable batteries, by which it is powered **Battery energy storage** Battery energy capacity depends on vehicle requested mileage before recharging. As an example, the capacity of Renault Fluence Z.E.'s lithium-ion battery is 22kWh for 185 km of autonomy, estimated on the New European Driving Cycle (NEDC). BEV batteries operate as energy storage device rather than power buffers as in conventional HEVs. Hence, BEVs typically require deeper battery charging and discharging cycles than conventional HEVs. Because the number of full cycles influences the battery life, this may be less than in traditional HEVs which do not fully deplete their batteries. However, advanced battery technology is under development,

	particularly Li-Ion technology, promising greater energy densities by both mass and volume, and battery life expectancy is expected to increase.
Operation and maintenance	Maintenance of BEV is simpler and cheaper than conventional thermal vehicles and HEVs. However, special technician trainings are required in order to perform adequate and safe maintenance and repair. BEVs may need a battery change over the vehicle life. Battery costs range between 800 USD/kWh and 1000 USD/kWh. The long term battery costs are expected to be 300-500 USD/kWh by 2015.
Endorsement by experts	· BEVs are endorsed by automotive manufacturers, in order to avoid paying excess emissions penalties.
Advantages	· **Energy efficient**: Electric motors convert 75% of the chemical energy from the batteries to power the wheels, where internal combustion engines only convert 20-30% of the energy stored in gasoline on highway and less than 15% in urban area. · **Environmentally friendly**: BEVs emit no tailpipe pollutants, although the power plant producing the electricity may emit them. Electricity from nuclear-, hydro-, solar-, or wind-powered plants causes no air pollutants. · **Performance benefits**: Electric motors provide quiet, smooth operation and stronger acceleration and require less maintenance than ICEs (estimated by Renault to be half of an equivalent ICE). · **Reduce energy dependence**: Electricity is a domestic energy source. · **Lower operating costs**: though BEVs will cost more than comparable conventional vehicles, operating costs will be less since electricity is much cheaper than gasoline, but it is unclear whether these savings will offset the vehicle cost when BEVs are first introduced. Incentives will play a decisive role in promoting BEVs.
Disadvantages	· **Driving range**: Most BEVs can only go about 160 km before recharging, where gasoline vehicles can go over 500 km before refueling. The low driving range of BEVs is mainly affected by the low specific energy of batteries compared to gasoline. · **Recharge time**: Fully recharging the battery pack can take 4 to 8 hours. Even a "quick charge" to 80% capacity can take 30 min. However, the concept of quick-drop in battery swap stations is under study. · **Battery cost**: The large battery packs are expensive and may need to be replaced. To reduce the cost impact, some automotive manufacturers will be renting the batteries. As an example, Renault Fluence Z.E. will be sold in certain countries at prices similar to those of comparably diesel versions. In France, for example, prices will start at 20900 Euros (5000 Euros tax incentive deducted). Regarding the batteries, customers will have to subscribe to a monthly lease starting from 82 Euros including VAT (assistance included) to cover the battery at a level of 10000km/year. · **Bulk and weight**: Battery packs are heavy and may take up considerable vehicle space. · **Recharging infrastructure**: It is assumed that BEV recharging will take place overnight at home. However, residents of cities, apartments, dormitories, and

	townhouses do not have garages or driveways with available power outlets, and they might be less likely to buy BEVs unless recharging infrastructure is developed. Electrical outlets or charging stations near their places of residence, or in commercial or public parking lots or streets or workplaces are required for these potential users to gain the full advantage of BEVs. However, this infrastructure is not in place today and it will require investments by both the private and public sectors.
Capital costs	
Additional cost to implement mitigation technology, compared to "business as usual"	Additional costs must be considered at two levels: · **Batteries**: current lithium-ion batteries cost around 15000 Euros in BEV prototypes, and are expected to be reduced to 3000 USD by 2020. This requires the battery to be about 200-250 USD/kWh. · **Recharging infrastructure**: in addition to the battery extra costs, there is a need for investment into the recharging infrastructure: – a simple recharging point at a private house or at an office costs about 1800 USD – a public recharging station, with the necessary electronics to make contact with the bank costs about 18000 USD A considerable advantage of BEVs is that the operating costs are considerably lower than the costs of a conventional vehicle. However, it depends strongly on the fuel and electricity prices to decide whether it is worth to invest the additional costs compared to a conventional gasoline powered vehicle.
Development impacts, direct and indirect benefits	
Cost benefits	Figure 2 illustrates the operating cost savings of BEV, HEV and PHEV, compared to the average new vehicle fleet operating cost of 2005. The total vehicle kilometers traveled per year is estimated 10000km, and the electricity tariff 0.15 USD/kWh. · With the current fuel price trend (~1.2 USD/liter), savings of the Nissan Leaf are 600 USD/year, comparing to the average fuel consumption cost of the 2005 world new car fleet. · These savings can reach 750 USD/year with other BEVs presenting better vehicle efficiency. Note that additional savings are achieved by comparing to the average fuel consumption cost of the whole 2005 Lebanese car fleet, since the average consumption far exceeds the 2005 world average of 8.07 l/100km. Figure 3 highlights the influence of electricity tariff increase with a fuel price estimated at 1.2 USD/liter and 10000 km/year. As electricity tariff increases, operating cost saving of BEVs are lowered, and PHEVs and HEVs would become more beneficial. As an example, the plug-in Prius presents better cost savings than the Nissan Leaf as electricity tariff exceeds 0.2 USD/kWh; same for the HEV Prius as electricity tariff exceeds 0.25 USD/kWh.

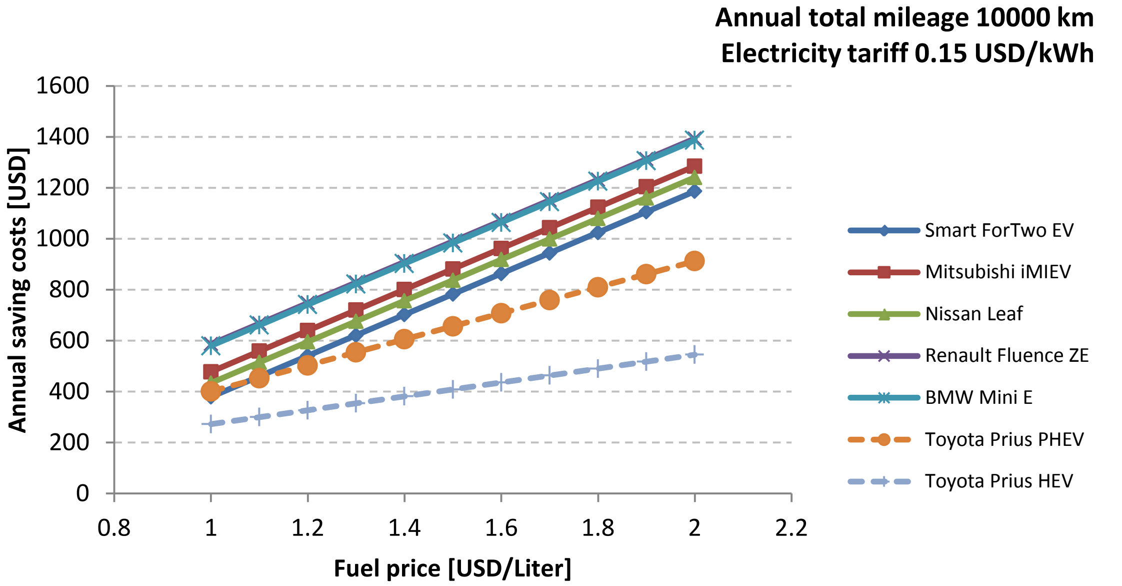


Figure 2. Annual operating saving costs of BEVs comparing to 2005 new fleet world average, as function of fuel price, with an annual mileage estimated 10000 km and electricity tariff of 0.15 USD/kWh.

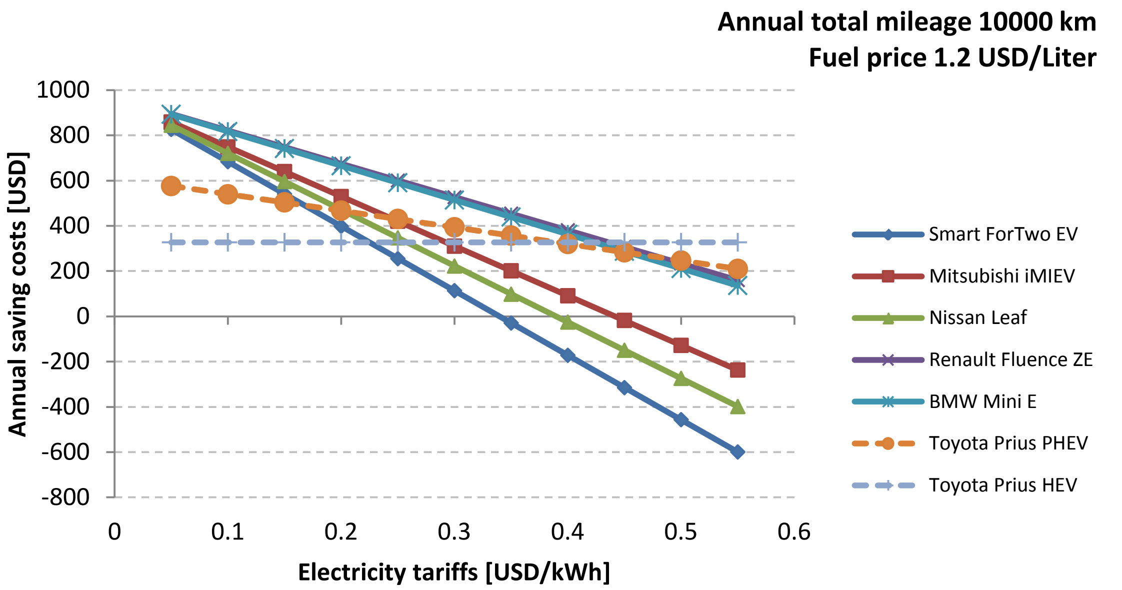


Figure 3. Annual operating saving costs of BEVs comparing to 2005 new fleet world average, as function of electricity tariffs, with an annual mileage estimated 10000 km and fuel price of 1.2 USD/liter.

Environmental benefits

Total energy use

Figure 4 outlines the Well-To-Wheel (WTW) total energy use of a typical BEV under different scenarios of electricity generation mix. The current Lebanese mix and the two mitigation scenarios that were proposed in the Second National Communication of the MOE are considered and compared to the US, France and world generation mix.

- WTW energy use in Lebanon is 102.8 kWh/100km with the current Lebanese electricity mix, 30.8% more than HEV, thought the vehicle operation efficiency of the BEV is 52% better than the HEV.
- 30 and 40 % of energy use savings would be observed in 2030 by adopting the proposed mitigation scenarios that were proposed in the Second National Communication.

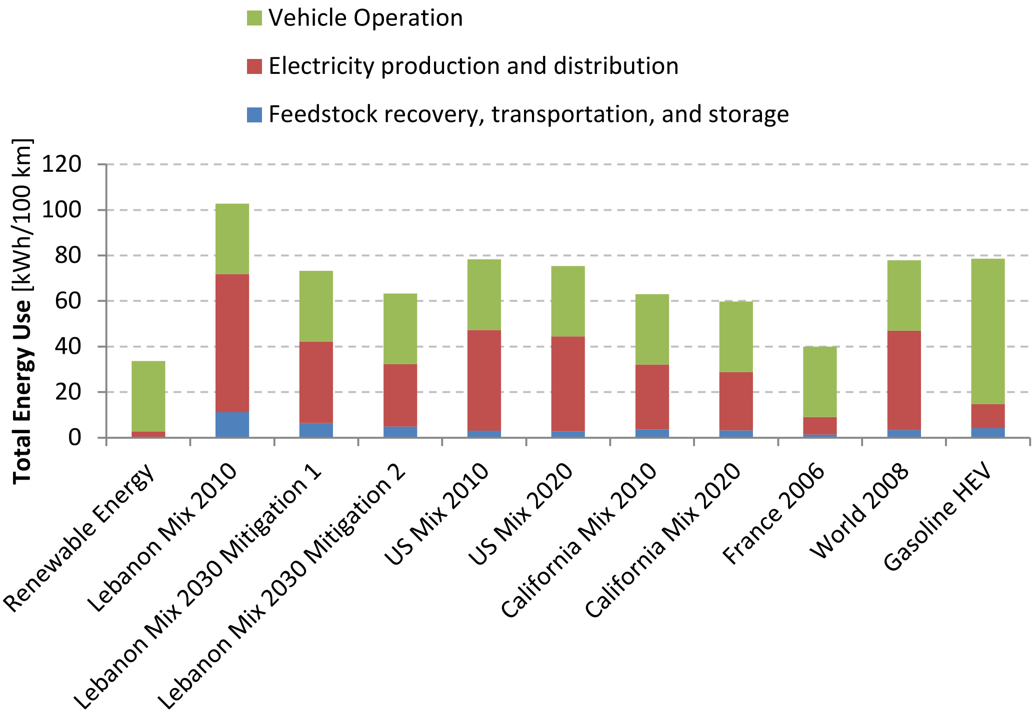


Figure 4. WTW total energy use of BEV and HEV using different electricity generation mix.

GHG emissions reduction

Figure 5 outlines the WTW GHG emissions change of a typical BEV comparing to a 2005 mid-size conventional vehicle that consumes 10 l/100km.

- With the current Lebanese electricity production mix, almost no GHG savings are observed with BEV (-0.2%).
- However, 39.1 and 52.7% of GHG savings are observed with mitigation scenarios for 2030.

Pollutant emissions reduction

BEVs have no tailpipe emission of air pollutants, which means that they can substantially contribute to improving local air quality, especially in urban areas. The global improvement of the air quality however, is determined by the way the electricity used is produced. For Lebanon electricity mix of 2010, the power plants have substantial emissions of NOx and PM, as illustrated in figure 6.

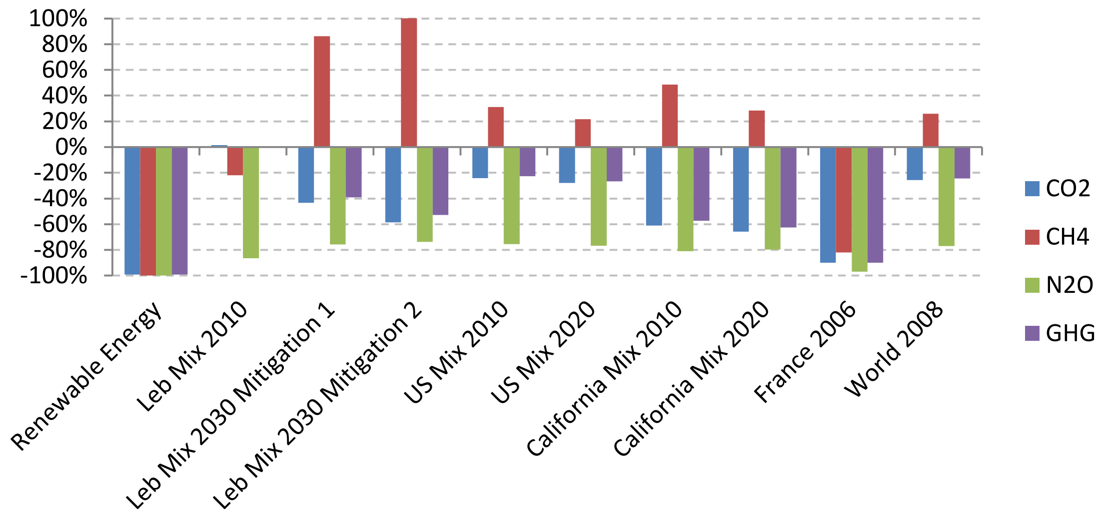


Figure 5. WTW GHG emissions change of BEV and HEV comparing to 2005 conventional vehicle.

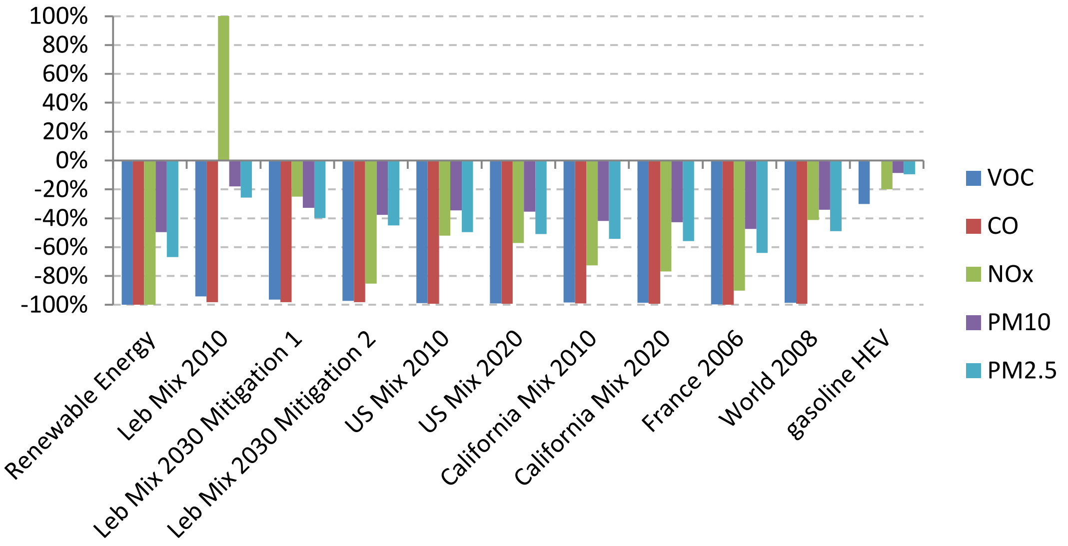


Figure 6. WTW pollutants change of BEV and HEV comparing to 2005 conventional vehicle under urban driving conditions.

Local context	
Status	No BEVs are available in the Lebanese car fleet. BEVs are expected to be on the market worldwide in the medium term.
Timeframe	**Medium-long term implementation** BEVs' implementation could not start immediately. A specific recharging infrastructure is requested. Many efforts are invested toward creating universal safe standard recharging stations. Different pilot projects are ongoing worldwide to ensure the well-operation of the BEV concept, and learn lessons from drivers behaviors, charging time, charging frequency, charging location, daily driving mileage, mileage between charging events, and other influencing parameters. BEV concept is expected to become a mature expandable technology on the short to medium terms.

[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/**