Learning Resources

Part I: Electric Vehicles

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UN-Habitat
For a Better Urban Future

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UN Environment
Clean Vehicle Options
The suitability and technological readiness of the different fuel options varies by vehicle type and field of application. Detailed information on clean fuels for buses can be obtained from www.clean-fleets.eu. The table below provides an overview of important advantages and disadvantages of different alternative fuel or technology types with a focus on buses. More details can be found in the Clean Fleets report: http://www.clean-fleets.eu/fileadmin/files/Clean_Buses_-_Experiences_with_Fuel_and_Technology_Options_2.1.pdf
CNG vehicles: Pros and Cons

**Pros**

- Major savings in PM and NOx emissions compared to traditional diesel (but not to Euro VI) buses.
- Relatively lower premium on cost of acquisition of CNG buses compared to other technologies.
- Mature market, numerous experiences identified.

**Cons**

- Natural gas is a non-renewable, fossil fuel and WTW CO2eq emissions are not significantly better (or can be even worse) than traditional diesel engines.
- Some safety concerns reported regarding storing gas on board.
Bio-fuels: Pros and Cons

**Pros**

- Significant Well-To-Wheels (WTW) CO2eq savings compared to traditional diesel buses, especially when methane emissions are avoided.
- PM emissions almost zero. Up to 30-80% reduction for NOx recorded in comparison to traditional diesel engines (< Euro VI models).
- Technology is the same as CNG, therefore there is a relatively well developed market, and a lower premium on the cost of acquisition of biogas buses compared to newer technologies.

**Cons**

- The potential volume of production from waste is relatively small. A much larger potential comes from the gasification agricultural products.
- Fuel prices and availability will strongly depend on local market conditions and the supply chain.
- Some safety concerns reported regarding storing gas on board.
GHG Mitigation Potential of Bio-Fuels

- The greenhouse gas (GHG) mitigation potential of biofuels varies largely and depends on the feedstock (see figure on the right), the farming practices, the refining operation and the potential induced land-use changes. Furthermore, additional aspects such as increasing scarcity of agricultural land due to reusing food, feed and biofuel demand have to be taken into account to assess the sustainability of biofuels. In general, biofuel generation from organic waste is favorable when compared to energy crops in terms of GHG emissions and environmental effects.

Overview of lifecycle emissions of different bio-fuels

Source: Bongardt et al. 2013: Low-Carbon Land Transport
Bio-diesel: Pros and Cons

Pros

- This strongly depends on feedstock (waste oils cause the lowest emissions, palm oil the highest – depending on processing methods)
- Although PM2.5 and NOx emissions can be higher
- Fuel supply costs depend on local market conditions and may depend on financing, e.g. tax relief
- Implications of converting land away from natural habitats or from food-related cultivation

Cons

- WTW CO2eq savings can be very high compared to traditional diesel
- Tailpipe PM10 emissions can be significantly lower than traditional diesel
- No premiums for cost of vehicle acquisition
- It is a renewable fuel derived from vegetable oils and waste oils.
Diesel – Electric Hybrid

Pros

• WTW CO2eq emissions savings can reach around 30% compared to traditional diesel buses, as can tailpipe emissions
• This is now a reasonably mature technology, with similar reliability to a standard diesel bus.

Cons

• However this varies according to what extent the electric motor is used. It is strongly dependent on the duty cycle, the topography of the route, congestion and driver efficiency.
• Diesel is a fossil fuel.
• Costs of acquisition can be 50% more when compared to traditional diesel buses.
Plug-in Hybrid Electric Vehicles (PHEV)

Pros

• Significantly lower WTW CO$_2$eq emissions compared to traditional diesel buses
• Lower energy consumption compared to diesel-electric hybrids.
• Flexibility to operate in EV mode in noise and pollution-sensitive areas.

Cons

• However, WTW CO$_2$eq emissions strongly depend on the origin of the electricity used, and on the proportion of time operated in full electric mode
• Relatively immature technology therefore there are limited experiences with this technology type.
Battery Electric Vehicles (BEVs)

Pros

• High potential for WTW CO\textsubscript{2}eq savings, almost 100%
• Zero tailpipe emissions and noise pollution

Cons

• WTW CO\textsubscript{2}eq and embedded NO\textsubscript{x} and SO\textsubscript{x} emissions totally depend on the origin of the electricity used.
• Relatively immature technology therefore currently very high relative costs of acquisition. Costs associated with infrastructure can vary widely depending on how it will be used and any existing infrastructure. There are limited experiences with this technology type.
• The need for recharging can limit flexibility
Hydrogen Fuel Cell

Pros
- High potential for WTW CO$_2$eq savings, almost 100%
- Zero tailpipe emissions
- Have shown good performance during trials and have high route flexibility, comparable to diesel buses.

Cons
- WTW CO$_2$eq emissions depend on hydrogen production methods.
- Immature technology therefore it is only possible to use the buses as part of a trial or demonstration.
- There is a lack of experience with hydrogen as a fuel, therefore there is little safety legislation.
End of Module: Clean Vehicle Options