Deliverable

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Context and Purpose

This deliverable represents the first fundamental step for the developing of the measure.
The document compares existing technological possibilities and prospects to develop clean buses for public transport.

Summary Contents

The study aimed to identify the best technological solution to introduce low pollutant buses in Bologna scenario.

ATC realized the analysis for the development of a bus fleet with characteristics of environmental sustainability and reasonable costs. The study takes into account the state of the art and the market trend of buses, considering development and technological innovations concerning environmental sustainability.

The range of methodologies available to evaluate the different solutions were:

- ✓ life cycle assessment (LCA);
- ✓ life cycle cost (LCC);
- ✓ well to wheel (WTW).

“Life-cycle cost” (**LCC**), refers to the total cost of ownership over the life of an asset. Costs considered include the financial cost which is relatively simple to calculate and also the environmental and social costs which are more difficult to quantify. Typical areas of expenditure which are included in calculating the whole-life cost include planning, design, construction and acquisition, operations, maintenance, renewal and rehabilitation, depreciation and financial costs and replacement or disposal.

Whole-life cost analysis is often used for evaluation of options when procuring new assets and for decision-making to minimize the asset life-cycle costs. It is also applied to comparisons of actual costs for similar asset types and as feedback for future design and acquisition decisions. The primary benefit is that costs which occur after an asset has been constructed or acquired, such as maintenance, operation, disposal, become an important consideration in decision-making. Previously, the focus has been on the up-front capital costs of creation or acquisition, and organisations may have failed to take into account the longer-term costs of an asset.

A “life cycle assessment” (**LCA**) allows to assess each and every **impact** associated with all the stages of a process from-cradle-to-grave (i.e., from raw materials through materials processing, manufacture, distribution, use, repair and maintenance, and disposal or recycling). LCAs can help avoiding a narrow outlook on environmental, social and economic concerns. This is achieved by:

- Compiling an inventory of relevant energy and material inputs and environmental releases;
- Evaluating the potential impacts associated with identified inputs and releases;
- Interpreting the results to help making a more informed decision.

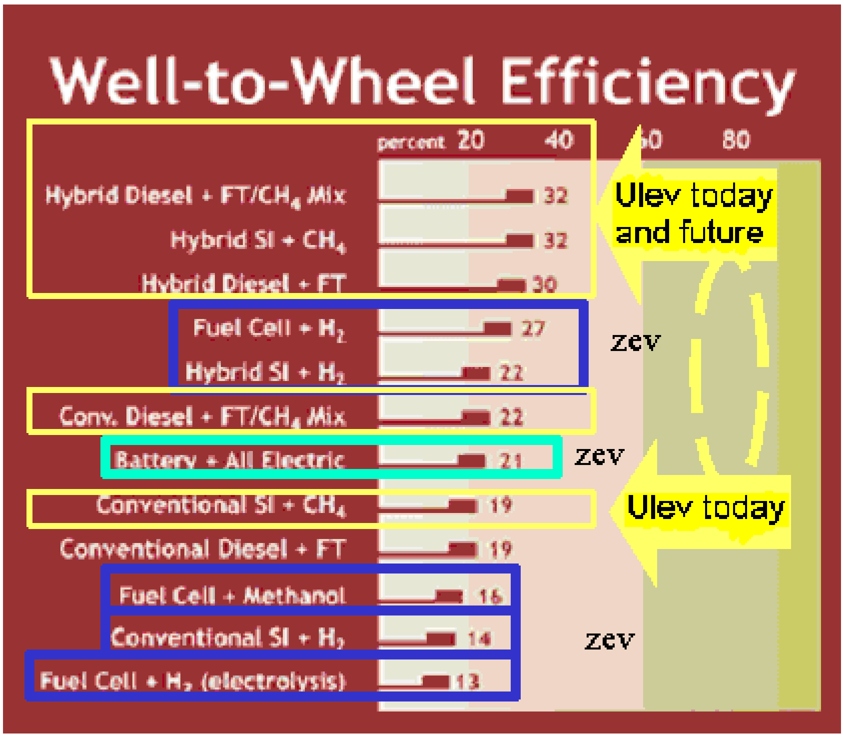
The goal of LCA is to compare the full range of environmental and social damages assignable to products and services, to be able to choose the least burdensome one.

The term 'life cycle' refers to the notion that a fair, holistic assessment requires the assessment of raw material production, manufacture, distribution, use and disposal including all intervening transportation steps necessary or caused by the product's existence. The sum of all those steps – or phases – is the life cycle of the product.

The “**well to wheel**” (**WTW**) approach was particularly interesting: this method evaluates the whole energetic chain of bus engines starting from the fuel production arriving to the bus wheel.
It consists of two parts:

- “Well to tank” that means evaluation of energetic consumption to extract and transport the fuel to the bus tank;
- ”Tank to wheel” from the vehicle tank to the vehicle wheels.

At the end, adopting the last methodology, the study concludes that the best “well to wheel” solution is buses with hybrid engines.



Hybrid vehicles reduce petroleum consumption under certain circumstances, compared to otherwise similar conventional vehicles, primarily by using three mechanisms:

1. Reducing wasted energy during idle/low output, generally by turning the internal combustion engine off;
2. Recapturing waste energy (i.e. regenerative braking);
3. Reducing the size and power of the internal combustion engine, and hence; inefficiencies from under-utilization, by using the added power from the electric; motor to compensate for the loss in peak power output from the smaller internal combustion engine.

Any combination of these three primary hybrid advantages may be used in different vehicles to realize different fuel usage, power, emissions, weight and cost profiles. The internal combustion engine in a hybrid vehicle can be smaller, lighter, and more efficient than the one in a conventional one, because the combustion engine can be sized for slightly above average power demand rather than peak power demand.
The power curve of electric motors is better suited to variable speeds and can provide substantially greater torque at low speeds compared with internal combustion engines.
Substantial use of the electric motor at idling and low speeds implies reduced noise emissions.

The study shows how hybrid vehicles are the best solution both for companies that already invested in alternative buses (trolley buses, natural gas buses) and reached the saturation point of infrastructures and for companies that have no possibilities to invest in infrastructures because hybrid technology is the only possibility to reduce energy consumption in the medium term.

An organizational analysis is conducted to understand the impact of the new technology introduction in public transport company: a new buses choice must correlated to a development of competences!

Indeed if a public transport operator doesn't develop internal competences on new traction systems in the medium term it will be constrained to acquire them from the vehicle suppliers with considerable costs.

Following the analysis results, hybrid engine will be adopted for the development of the small fleet of vehicle in Bologna.

Functional Use

Deliverable 1.1 is fundamental for the developing of the measure. The feasibility study allowed to choose the best economical/technical solution to develop innovative clean vehicles.

Lessons learned

A company willing to develop a "sustainable" bus fleet should consider that sustainability has not only technological implications but also cultural impact on the company organization.

Before the purchase on the market of low environmental impact buses, the company should improve its internal processes as concerns:

- personnel training;
- adaptation of maintenance process;
- adaptation/realization of infrastructures;
- logistics for the supply of innovative fuels.

This cultural impact explains why the introduction of new sustainable vehicles is possible only in the medium-long period. Without a "cultural" approach the company will face high costs of operation and low service level of new buses.

Attachment

Feasibility study

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