

POLITECNICO DI MILANO

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150<sup>o</sup>

the European Mobility Week  
Milan  
(16-22 settembre 2013)

The electric mobility at the Mechanical  
Department of the Politecnico di Milano

Ing. Davide Tarsitano

The electric mobility at the Mechanical Department 2

**Current activities**

- The BUS NON STOP project
- The electric Hybrid plug-in Truck mixer
- The E\_CO SPIN OFF
- The Shell Eco-Marathon Vehicles

**Past activities**

- Plug-In Fiat Grande Punto
- 35q Plug-In van for good delivery
- GreenFun

Nome relatore POLITECNICO DI MILANO

### The principal problems of electric mobility

The main problems that have always held back the spread of electric mobility are essentially of three types:

1. Electrochemical storage systems is not efficient:

- Life cycle (400-2500 cycles of charge / discharge, disposal at end of life).
- Energy density (additional weight / additional volume / autonomy of the medium relatively poor).
- Minimum time to recovery of the electrochemical characteristics (charging times, only partial absorption of regenerative braking).
- Scarcity of raw materials.

2. Infrastructure costs high.

3. Maintenance costs for fleets reduced.

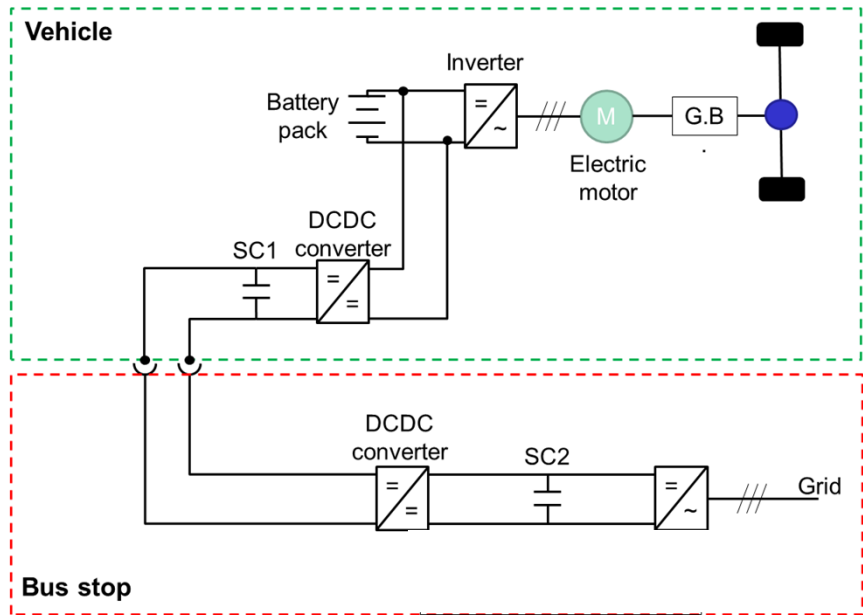
### The project

- ✓ The BUS-NO-STOP project is a zero emission transportation system which involves a radical change of perspective regarding energy supply, buses and passengers in an urban system.
- ✓ The perspective change consists in the following: only the energy needed to cover the distance between one stop and the following stop is carried on board. The energy is stored at each bus stop through charging stations which recharge the on-board Lithium Ion Capacitors in the extremely short time needed for passengers to exit and enter the bus.
- ✓ Lithium Ion Capacitors (LIC), however, have a much higher energy density; and have fundamental advantages over electrochemical charge storage systems (batteries):
  - The life cycle: up to 1 million charging cycles without significant loss of efficiency.
  - The fact that charge and discharge can be very rapid: 15/20 seconds.

**...The project**

- The transport system constructed will be constituted by a bus of reduced dimensions strongly innovative and two charging stations.
- The BUS-NO-STOP project includes a mixed system supercapacitors and lithium batteries.
- The peculiarity of the project is constituted by the innovative charging system which will allow a significant reduction of the weight and size of battery packs installed on the vehicle, without going to affect performance.
- The idea behind the project is to take the energy needed to carry out the mission of a city bus, not by a very large battery pack installed on board, but rather take the energy needs during the journey through the "distributors" of energy taken from the mains.

**The BUS NON STOP project**



### On-board power management strategy

1. The strategy has to use supercaps in order to reach the following bus stop with a low SOE (Status Of Energy).
2. The strategy has to guarantee the driving performance of the bus among the whole drive cycle without any reduction.
3. The strategy has to let the battery to work in steady state condition avoiding overload conditions.
4. The strategy has to discharge the battery at reduced C-rate in order to preserve its life.
5. The strategy has to be independent from traffic.
6. The strategy has to self adapt according to traffic conditions and to possible route deviations.

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## ENERGYA E9: New Cifa Hybrid Truck Mixer



### MAIN FOCUS

- **CIFA ENERGYA E9** is the first Hybrid Plug-in truck mixer adopting technologies **to decrease fuel consumption, pollution and noise**
  - conventional hydraulic system replaced by electric transmission with high efficiency components
  - full electronic management system oriented to energy saving
  - kinetic energy recovery system (KERS) during vehicle braking phase and drum braking phase
  - possibility to move the drum with diesel engine off, during the charging and discharging phases
  - emission and noise reduction get **CIFA ENERGYA E9** very useful in all areas with **high respect for the environment**

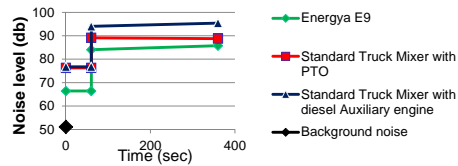
- **Energy charging modes:**
  - **Slow speed plug-in charging mode**
    - **380V / 400V - 16A** standard plug-in for industrial application (Recharging time approximately 4 hours for a full)
  - **High speed plug-in charging mode**
    - **three-phase 380V / 400V – 75kW**  
(Recharging time approximately 18 min for a full recharge starting from a 20% battery charge level)
  - **Generator charging mode**
    - Recharging through generator connected to Diesel  
the endurance is completely guaranteed: during transport on road the generator is able to give enough power to recharge battery and move the drum



▪ **Noise level:**

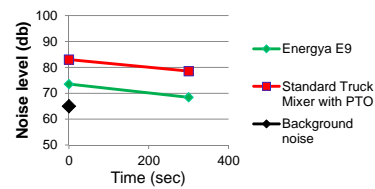
• **Noise level at the batching Plant**

- 4db respect standard PTO Truck mixer
- 10db respect Truck Mixer with auxiliary engine



• **Noise level at the construction site**

- 10db respect standard PTO Truck mixer



▪ **Fuel saving:**

• **Full electric mode:**

- (only recharging in plug-in mode)
- 25/30% of Fuel Saving

• **Generator recharging mode**

- (recharging from low speed plug-in and from generator)
- 15/20% of Fuel Saving

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**E-CO srl**

**E-CO Electric & Hybrid Drive Company** is the Politecnico di Milano's Spin-off dedicated to the hybrid conversion of vehicles, for the diffusion of a real sustainable mobility.

- > The main activities are: design, development, marketing and systems integration of hybrid and electric powertrains to obtain vehicles with low or no environmental impact. Among the activities there is also the development of conversion systems for boats.
- > There are four operation areas:
  - ✓ Kits production for hybrid conversion (Market sector: "Automotive Transformers")
  - ✓ Custom hybrid transformation for fleets of vehicles with standard and/or specific applications (market sector: PA, Corporate)
  - ✓ Custom hybrid transformation for fleets of boats
  - ✓ Technological support (Design & Engineering) of hybrid systems for Car makers/OEMs to develop own vehicles and sub-systems.



## E-CO srl – Partners and main competences

E-CO was born from the synergy of **3 very qualified partners**:

- ✓ Politecnico di Milano, for the mechatronics development of bimodal solutions
- ✓ IRETH, for Business&Corporate Development
- ✓ Mecaprom Technologies Corporation Italia for the development of REV (range extender) solutions and the products industrialization.

Among the **main competences**:

- Vertical Know-how about Vehicle System and Boat System
- Concept and development of hybrid series and parallel conversion systems
- Concept and development of innovative powertrain systems with high level technology
- Concept and development of endothermic engines and transmissions
- Preparation and development of prototypal vehicles and fleets
- Conversion of small series vehicles/fleets
- Know-how about productive processes, in particular about powertrain systems, both for small productive volume and for massive production.

## E-CO srl - Technologies

E-CO works on two technologies, essentially:

- **E-CObim**: an innovative high-performance kit, coupling the conventional combustion engine with an electric engine powered by innovative lithium batteries, allowing traction in three different modes: Endothermic, Pure Electric and Hybrid. The applications go from A segment to C segment up to buses and heavy goods vehicles.
- **E-COrev**, a series-hybrid conversion system configured as range extender; its main features are flexibility, scalability and compact size over a wide range of vehicles: from A segment to B segment. It is particularly suitable for OEMs industry.

Both E-CO technology can be apply also to boats.



## E-CO srl – Added Values

- All features of E-CO conversion solutions are very innovative:
  - ✓ High engineering retrofitting on existing concept vehicles
  - ✓ High efficiency, high performances.
  - ✓ Significant reduction of fuel consumptions
  - ✓ Low pollutant emissions
  - ✓ Little invasive integration
  - ✓ High modular engineering, good to be integrated in different segment vehicles or boats and technologies
- Attractive and Growing market
- Very competitive solutions - referring to the present context - vs other existing solutions
- Significant and positive effects on the financial balance of the PAs/Companies/ Mobility Operators that would really realize sustainable mobility programs, leading to a more efficient management of their vehicles
- Quite limited risk for technology development, thanks to partners and competitive development scenario E-CO intends to plan.

## The electric mobility at the Mechanical Department

18

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Veicolo elettrico alimentato da celle fotovoltaiche

Il nome:

**Apollo** come  
nella mitologia  
è il fratello  
gemello di  
Artemide e dio  
del sole

Risultati e premi:

**2010**

- SEM Americas – Solare – 12546 mpg – **5460 km/l** miglior prestazione assoluta (guest team)
- SEM UK – Solare – 796 km/kWh – **7070 km/l** – **1° posto** – [nuovo record assoluto competizioni SEM](#)

**2011**

- SEM EU – Solare – **1108 km/kWh** – **9750 km/l** – **1° posto veicoli solari** – **1° posto classe e-mobility** – **nuovo primato mondiale**



Veicolo elettrico alimentato da celle fotovoltaiche

Il veicolo:

**Daphne** è un “urban concept” ha dimensioni e caratteristiche adeguate ad un veicolo da città.

Risultati e premi:

**2011**

- SEM EU – Elettrico – **125 km/kWh** – **1101 km/l** – 7° posto di categoria

**2012**

- SEM EU – Elettrico – **161 km/kWh** – **1418 km/l** – 6° posto di categoria

**2013**

- SEM EU – Elettrico – **165 km/kWh** – **1453 km/l** – 6° posto di categoria

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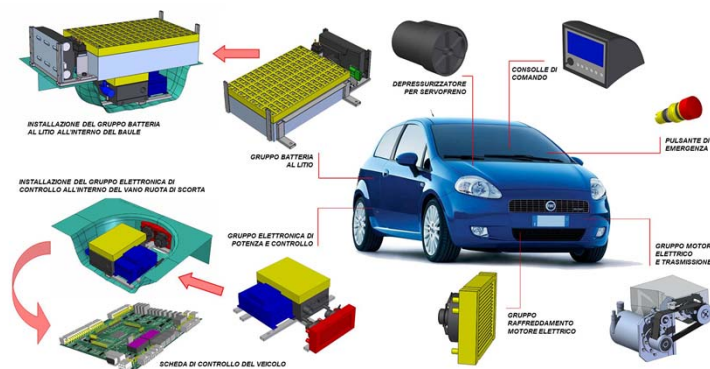
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**Plug-In Fiat Grande Punto**

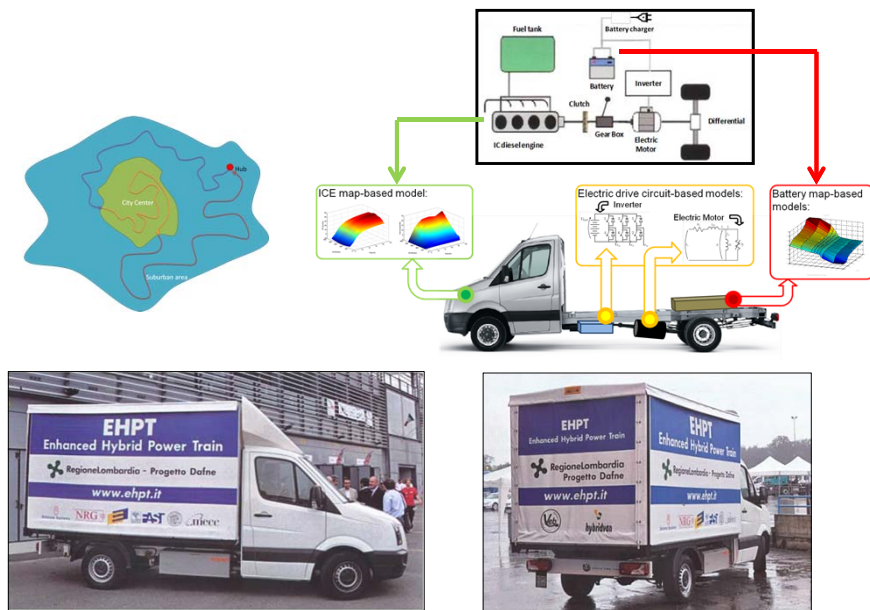
**Modalità Endotermico:** l'auto l'automobile funziona normalmente alimentata a benzina o gasolio e tutti i componenti dell'impianto di trazione elettrica sono disattivati.

**Modalità Elettrico:** il motore endotermico è disattivato e la marcia è garantita dall'impianto di trazione elettrico con prestazioni ridotte e zero emissioni (velocità max. 85 km/h, autonomia 35 km in ciclo urbano).



## 35q Plug-In van for good delivery

25



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## GreenFun

26



Veicolo quadriciclo intelligente ibrido/bimodale per mobilità urbana di persone, ecologico, sicuro e ad elevate prestazioni

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Dipartimento di Meccanica  
Road Vehicle Dynamics

Contacts:

**Prof. Federico Cheli**

Tel.+39 02 2399 8462

Fax +39 02 2399 8492

Federico.cheli@polimi.it

[www.mecc.polimi.it](http://www.mecc.polimi.it)