



Alternative propulsions for clean vehicles

Jean Delsey, INRETS

Predit 3 – Clean and energy-saving vehicles

- Decrease drastically the local pollution (NO_x and diesel soot)
- Decrease the global pollution by GHG and especially by CO₂
- Increase the energetic efficiency – measured in Wh/km (per passenger-km or ton-km)
- Reduce the noise and the impact on populations

Predit 3 – Permanent research to obtain clean, energy-saving and silent vehicles

- Academic research for a best knowledge:
 - combustion, catalyst...
 - electrochemistry
 - materials
 - models...
- Applied developments:
 - components (fuel injection, sensors, batteries, software...)
 - functions (internal combustion engines, architectures,..)
 - demonstrators (vehicles or part of it)

For all the vehicles: two-wheels, passenger-cars, urban trucks, buses, heavy trucks, trams, metros, trains

Predit 3 - Some evolutions for the internal combustion engines (1)

- Drastic depollution (NO_x and particles): catalytic systems, additives, EGR...
- Internal aerodynamics
- Fuel injection (direct injection for spark engine, high pressure for diesel)
- New concepts for the combustion (CAI and HCCI)
- Optimization for alternative fuels (natural gas, bio fuels-1st and 2nd generation, synthetic fuels...)
- Gains: 20% on the energetic needs for the same power

Predit 3 - Modifications of the internal combustion engines (2)

- Downsizing: decrease of the cubic capacity of the engine with keeping the same performance
- Variable compression engine - Camless system engine (spark and diesel)
- Optimized control of the engine in connection with the use of the vehicle
- Gains: 10 to 20%

Predit 3 - Revolution: the passage to electric motorisations

- From light to full hybrids
- Optimized architectures - depending of the vehicles and of the uses (passenger-cars, buses, urban trucks...)
- Electronic functions (efficiency, durability,..)
- Electric motors - classic and advanced (efficiency, durability, cost, weight and volume...)
- Adaptability of internal combustion engines for hybrids and energy management
- Batteries and other electric or energetic storage system (efficiency, cyclability, ageing, cost...)

Predit 3 - Energy storage

- Applications for the electric vehicles and for the hybrid vehicles
- Analysis and experiments of batteries: Nickel-M-Hydrides, Lithium-Ion, Lithium –Iron-Phosphate, Lithium-polymer, Nickel-Chloride (Zebra)... (cycles, durability, cost... resistance to vibrations, temperature...)
- Analysis and integration of super capacitors
- Other systems (hydraulic and high-speed wheel)
- Objectives: performances, durability and decrease of the cost

Predit 3 - Auxiliaries and reduction of the weight

- Air-conditioner with high efficiency
- Optimization of the electric use in-board
- Electric auxiliaries
- Decrease of the weight for all the components
- Gains: 5 to 10% on the global energetic needs

Predit 3 - Research for the reduction of noise

- Noise from the tyre on road
- Noise and vibrations from tramways
- Analysis and decrease of noise from the braking system (road and trains)

Predit 3 - Demonstrators

- Passenger-car (PSA) :
 - down-sizing with a small gasoline two cylinders engine (and controlled turbo charge)
 - regenerative braking energy system (batteries and super capacitors)
- Bus (IRISBUS)
 - new architecture for the vehicle
 - optimized diesel engine
 - regenerative braking system (storage by hydraulic and electric systems)
- Tramway (ALSTOM) :
 - optimization of the global electric architecture
 - regenerative braking system (storage by high-speed wheel and electric motor)

Predit 4

- Continuation of **academic and applied researches** (combustion, materials, electrochemistry, modelisations...)
- **Development of very low-CO2 solutions** for internal combustion engines and vehicles (new engine, very low-weight vehicle...) and **optimization with alternative fuels** (bio fuels - 2nd generation and synthetic fuels)
- An important and specific program which is launched:
 - **development of hybrids and all-electric vehicles**
 - **with ten demonstrators : passenger-cars, light trucks, buses**
 - maintain of the **research on the main basic topics** (energy storage, electric motor, energy management...)
- Important points: **standardization of components** as batteries, electric motors connecting systems... (new methods for the evaluations of components , and especially for electric components and electric functions), **decrease of the costs**
- Optimization of vehicles versus real uses: new tests cycles (?)