European Green Car Initiative
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Panel
Impact and future Outlook

The Easy Way to Electromobility

Pietro Perlo, IFEVS
Outline

- Enabling tech are evolving fast:
  - Promote ambitious EU targets

- Relative risk per motorization:
  - Promote new design criteria to mitigate risks

- Vehicle vs infrastructures:
  - Re-focus on in-the-vehicle simplicity
  - Pursue open standards and avoid protectionism

- Innovation and speed toward people’s needs:
  - Involve specialized regional clusters more than SMEs
  - Introduce new financial mechanisms to turn success projects into successful EU manufactured products.
Theoretical specific energy for different types of Li-ion batteries.

Nanostructured Lithium Sulfide/Silicon demonstrated at 600Wh/kg. Yang, Stanford
Nanostructured SnC/Li₂S demonstrated at 1200Wh/kg Scrosati, Rome 2011.
Technology evolution: Specific energy and productivity of batteries

- Specific energy (Wh/kg) increasing 5-7% a year
- Productivity (Wh/h) increasing 20-25% a year*

The energy needed to produce 1kWh of battery cells is halved every five to six years.

Since the commercial advent of the Li-ion battery the energy needed to produce 1kWh of capacity has been reduced to less than 1/10th.

Price at 200€/kWh well before 2020!

* Data provided by Kemet-Bologna a major world-wide supplier of equipment for the production of battery cells.

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• Average speed in most large EU cities is below 10kmh (London 3kmh)
• Electric means do not mitigate congestion unless they are on average much smaller than conventional cars

*Source: Intelligent mobility a national need? Automotive Council, UK, November 2011

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Dynamic of road mobility of people

A complex problem with fast evolving variables:

- Technology evolution,
- Implications on health: noxious emissions and noise pollution,
- Congestion and closure of city centres,
- Cost and availability of resources: primary energy and raw materials,
- Climate change: GHG,
- Private versus public transportation,
- Competition-employment, strategy of nations….

The invariants in mobility

- People move in average 1 hour /day
- Average speed 35kmh since the first time it has been measured
- Sens of freedom: all obligatory solutions sooner or later fail
The decline of the conventional offer

- In Europe 500 cars every 1000 inhabitants* (Italy 690)
- Lifetime 8 years
- The Internal Combustion Engine is a consolidated technology
- The EU sales of conventional cars is decreasing for the fifth year (ACEA 2012)
- 64% of new sales in EU are small and medium small vehicles (ACEA 2012)

More mobility but with different means-modalities

There is a clear tendency to produce smaller cars. Japan is leading the trend.

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EU Road mobility 2010-2020

2020: -30% km run with ICEs is very likely

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EU Road mobility 2010-2020

km run by mode normalized to a 1400kg car.

2020: 8-12% all hybrids

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E-Vehicles in between 650-1000kg meet most of the needs.

- The first option for vehicles below 1000kg will be electric.
- All cars below 700kg will be electrical.
Promote new design criteria to mitigate risks

The safety of motorised two-wheelers in the EU: Motorcycle or moped travel death risk is 17 (per time) to 20 (per distance) times higher than for car travel. Source: European Transport Safety Council Transport safety performance in the EU a statistical overview.

Fatalities per billion kilometers: Airplane: 0.05 - Bus: 0.4 - Train: 0.6 - Truck: 1.2 - Boat: 2.6 - Car: 3.1 - Bicycle: 44.6 - Foot: 54.2 - Motorcycle: 108.9 (Source TRL)

Keeping the feet on the ground is rather unsafe!

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Classification of means per mass and energy consumption

Currently 70kg of battery pack over a range of 150km
(near term < 60kg)
(Price of mature products = 1.6-2.0 x aver. cost of raw materials €/kg)
Technology evolution: Smart photovoltaic (P-MOB)

- High efficiency Monocrystalline silicon (>20% eff.)
- High efficiency achieved by partition and distributed electronic control
- Flexible panels on curved surfaces

PV Surfaces

- Target surface: 2.5 sqm
- Target energy: 1,2kWh/day year average in Torino
On-board “Smart” Photovoltaic (P-MOB)

Measurements confirm that the P-MOB vehicle can run the targeted 20km a day at a constant speed of 50kmh (speed at which the vehicle consumes less than 50Wh/km).

- Measured power consumption
  - With full weight 800kg
    - Constant speed
      - 50km/h: 48.37 Wh/km
      - 100km/h: 107.30 Wh/km
    - NEDC
      - No energy recovery: 80 Wh/km
      - Energy recovery 100%: 70 Wh/km

1600/75 = 21km/day

NEDC cycle (June 2012)

Provocation transformed into a low cost EU reality

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Potential of solar energy for mobility

- Average daily mileage potentially provided by solar energy harvested by a small e-car demonstrated with 2012 technology

![Map showing yearly sum of global irradiation and solar electricity generation](map.png)
Prototype vehicle and milestones:

P-MOB  PPP project

Milestones for future electromobility set on:

➢ Fail-safe two motor powertrain (four wheel drive)
➢ Efficiency with best in class aerodynamic
➢ Best in class safety against lateral crash
➢ «Five stars» ergonomy for a supercompact vehicle
➢ Smart photovoltaic capable of an average 20km/day by solar energy

(PPP driving provocations into real innovation)!

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Conclusions: PPP now and near term future

- Set New EU Roadmaps with more ambitious targets
  - Production numbers per typology of vehicles (mass)
    (examples: by 2020 5 M/Year of e-vehicles weighting less than 1000kg)
  - Pursue severe safety criteria per modality and mass
    (NCAP 5 for all four wheels e-vehicles, define equivalents for 2 and 3 wheels motorizations)
  - Set categories of energy consume
    (oblige embedded smart photovoltaic on all four wheels vehicles)

- Promote In-the-vehicle simplicity
  (the nonsense of current city e-cars with 20+kg of on-board power electronics! More projects addressing vehicle technologies, less projects addressing infrastructures)

- Promote the aggregation of SMEs clusters
  (well organized regional clusters of SMEs can cover most of the supply chain of the modern e-mobility and revolutionise the current status quo)! The Chinese example: E-mobility=new players!

- Need to introduce new financial rules to transform a successful project into successful EU mass produced products
  (To move from a good prototype to the demonstration of 20 e-vehicles with pre-production technologies cost as much as only two EU streps! But new PPP calls tend to repeat projects adding little or no relevant innovation rather than promote the production of the innovation reached) - Pursue the transformation of provocations into reality (real innovation) and keep an eye to avoid the PPP to become the commercial branch of national programs!)

Pietro Perlo, IFEVS
Thank you for your attention!

Pietro Perlo