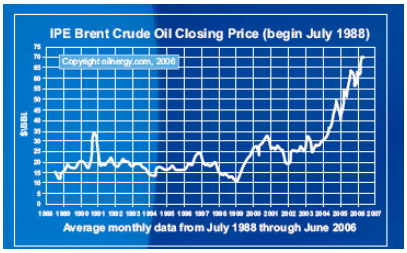
Education and Culture
Leonardo da Vinci

Action I/05/B/F/PP-154181
Energy Conversion Systems and their Environmental Impact
Promoter: Istituto Alfano I, Salerno, Italy
Coordinator: DIMEC, University of Salerno, Italy
www.dimec.unisa.it/leonardo

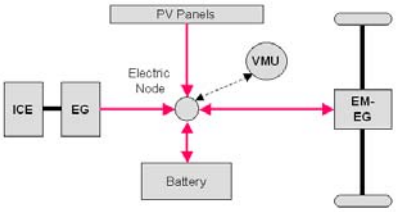
Why a Hybrid Solar Vehicle?

Fossil fuels are running out rapidly, while the CO_2 produced by internal combustion engines increases greenhouse effect leading to global warming and climatic changes.
Solar energy is a free, widespread, renewable source and photovoltaic panels technology is improved continuously even if, unfortunately, solar cars do not seem to be a valid choice to replace traditional thermal engines…
… whereas hybrid electric vehicles represent an efficient solution to reduce fuel consumption and emissions, optimizing on-board power sources operation and recovering energy through regenerative braking. However, they still use fossil fuels. Thus, solar vehicles might join hybrid vehicles and solar energy advantages.
For the most part, people use their cars for short ways in urban areas, roughly for an hour, with the driver on-board only. In that way, a significant amount of traction power may be recovered by panels during driving cycle and, above all, when vehicle is parked.
Several researches have demonstrated that hybrid solar vehicles may become economically competitive in few years, since oil price trend is increasing, photovoltaic panels' costs are reducing and government incentives have been introduced. A hybrid solar vehicle may be useful when parked and totally charged as well: energy surplus captured by solar panels may either be sold to the national electric company or be used to satisfy house energy requirements, reducing electric bills. As an alternative option, the on-board motor/generator may produce electric energy to recover heat for house needs (cogeneration), thus cutting down energy bills...
For further details: http://www.dimec.unisa.it/leonardo_new/en/hsv_introduction.php

Project home page:
www.dimec.unisa.it/Leonardo



Oil price trend



Hybrid Solar Vehicle scheme

THE PROTOTYPE

The choice

In the first stage of the project, different options have been investigated to build the hybrid solar vehicle prototype. First of all, it has been considered either to build a new vehicle all over again or to develop the project starting from an existing car. Even though the first solution appeared to be interesting, it was not feasible and consistent with time and budget limits. Moreover, the second option offered a better chance to apply previous know how and theoretic analyses. At that point, a vehicle typology had to be selected: a kart or a car, with thermal or electrical engine. Finally, an existing vehicle was chosen as basic structure for prototype development.

The framework

A "series hybrid vehicle" configuration seems to be the most suitable solution to match the framework chosen. In this case, traction power is supplied only by the electrical motor (EM/EG), which may operate also as generator during braking mode (regenerative braking). Photovoltaic panels (PV) and the motor/generator system (ICE/EG) either supply power to the electrical motor or charge the battery pack (Battery), accordingly to control system strategies (Vehicle Management Unit, VMU). Further details are available on the web site.

The electric vehicle

A "Porter Glass Van" by Microvett has been selected to develop the prototype. It is a light duty vehicle suited for urban and protected areas, due to the lack of gas emissions and noise. A "Porter Glass Van" has been provided to the research group by **Automobile Club Salerno** (ACS), one of the project sponsors. A significant surface for photovoltaic panels housing is available on the vehicle roof, while motor/generator and control systems may be placed in the large trunk. The powertrain includes an electric motor fed by batteries placed under the driver and passenger compartment. Technical data are available on the web site (www.dimec.unisa.it/leonardo_new/en/prototype.php)

Photovoltaic Panels

Referring to photovoltaic panels, different options have been investigated and proper choices have been made:

- What kind of panels has to be used? In order to work on a feasible solution, standard production silicon polycrystalline panels have been selected, rather than high efficiency gallium arsenide panels, capable to assure high performance but extremely expensive.
- A single panel or many smaller panels? The second option has been followed to optimize single panel control as a function of temperature and incoming solar radiation conditions, that may vary on different panels.
- How may panels be mounted on the vehicle? May they be integrated in the roof or an external support has to be provided? First solution guarantees a better aerodynamics and an enjoyable look. Second option assures higher

flexibility during design stage and suggests innovative ideas. For example, when vehicle is parked, panel orientation may change following sun position. Finally, a travelling platform has been chosen, taking into account that aerodynamic losses are negligible due to vehicle low speed. Following the roof profile by means of two articulations, an aluminium platform has been built by **Saggese**.

The Engine/Generator Group
A 6 KW YANMAR S6000 single-cylinder Diesel engine, air cooled, with electric starter, has been mounted in the large vehicle trunk, with the support of **CIMEP**. The electric output of the AC electric generator, at 230 V, was directly linkable to the vehicle circuitry. An acoustic insulator has been realized, with the support of Saggese. A window, with double glass layer, has been inserted to assure back visibility to the driver. A sandwich of insulating material has been chosen, to cut low and high frequencies, and a noise reduction of about 24 dB has been obtained.

What is the end of the story?
Follow the sequel of the story on the web site: www.dimec.unisa.it/leonardo_new/en/prototype.php


The Diesel Motor/Generator system.


Porter Glass Van donation to the research group by Automobile Club Salerno


The Prototype at Green-Prix 2007, in Sicily.

The web site
All design and construction processes are explained clearly on a multi-language web site, by using didactical modules and carrying out e-learning tools that allow to deepen energy and environmental topics, make self-evaluation tests, participate and assist to prototype construction, also from long distance.

Join the "Validator Team"
Entering the "Validator Team", you can help us to improve this project, contributing to the diffusion of themes about sustainable mobility. You will be part of a selected number of users and we will ask you just few minutes of your time to evaluate the project and the web site, filling in an on-line questionnaire and providing ideas and suggestions, by participating in a forum. Joining the "Validator Team", you will receive a periodical Newsletter about the project and related themes, in Italian and in English. http://www.dimec.unisa.it/leonardo_new/en/validator.php

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Leonardo Project I/05/B/F/PP-154181 "Energy Conversion Systems and Their Environmental Impact"
The project, funded by the European Union within Leonardo da Vinci Program, is promoted by Istituto Alfano I, Salerno, and coordinated by the Department of Mechanical Engineering at University of Salerno. The project involves a partnership including universities, companies, schools, research and formation centres from five European countries. The aim of the project consists in promoting knowledge about energy, economic and environmental themes, related to automotive transportation and renewable sources, through the construction of a low environmental impact hybrid solar prototype. This vehicle might guarantee significant reductions of fuel consumption and greenhouse gases emissions. The project started at the beginning of October 2005 and will last two years. Although the prototype may not be commercialized directly, it represents a valid practical and symbolic tool for a deeper comprehension of energy conversion devices operation. Moreover, the hybrid solar prototype should help to spread design critical issues and solutions related to the design of low environmental impact vehicles.

The Partners
Istituto Alfano I, Salerno, Italy (promoter) – DIMEC University of Salerno (coordinator) – ERFAP, Naples, Italy – Elettro Sannio Ricerca srl, Pietrelcina (BN), Italy – BUTE, Dept.of Control and Transport Automation, Budapest, Hungary - Université de Haute Alsace, Mulhouse Cedex - France - Dunarea De Jos University of Galati, Romania - Istanbul Technical University, Faculty of Mechanical Engineering, Turkey - Parco Scientifico e Tecnologico di Salerno e A.I.C., Salerno, Italy - Auto-Consulting, Fasano (BR), Italy – DIIIE University of Salerno, Italy

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