Project for the course

The Economics of Corporate Sustainability

HySolarKit

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HySolarKit

It was late in the morning when Professor Gianfranco Rizzo arrived in his office in the University of Salerno after one of his lectures in the engineering department. Once he sat, he took the accordion from one of the drawer and started playing the instrument. This ritual helped him in concentrating on one of the projects of which he was more proud but that was currently in a critical phase: indeed, several problems were coming out and many decision had to be taken to let HySolarKit become more than one of the several projects that get stuck at the lab stage.

The early stages - Before HySolarKit

Starting from 2006, University of Salerno has been active in the field of sustainable mobility and emissions reduction.
In the same year, the Leonardo Project “Energy Conversion Systems and Their Environmental Impact" was launched for the first time; it aimed at promoting the knowledge of the students in the field of energy conversion and related environmental problems, with particular emphasis on sustainable transportation, by means of the active participation in a didactic project for the design and manufacturing of an innovative prototype of hybrid solar vehicle.
The focus on hybrid solar vehicles was nothing new to the energy and engineering departments, but it was not well renowned among students, despite its potentially huge impact on everyday life in the upcoming years: indeed, this kind of vehicles could significantly contribute in reducing fossil fuel utilization and carbon dioxide emissions, at the same time allowing significant monetary savings.

The students selected for the project started a close collaboration with the supervisor of the project, Professor Gianfranco Rizzo, from the Department of Industrial Engineering (DIIn) of University of Salerno.

Professor Gianfranco Rizzo, born in Naples in 1952, got a degree in Mechanical Engineering at University of Naples and worked at FIAT and at the National Council of Italy, before choosing the academic path and working for University of Naples and University of Salerno, where he is Full Professor in Mechanical Engineering. He also worked as an independent consultant to research projects for many Italy-based firms (Magneti Marelli, Elasis, Snam, and Acer – all operating either in the automotive or in the energy sector). His main fields of research include Modelling and Control of Automotive Engines, Modelling and Optimization of Conventional and Hybrid Power Plants, Renewable Energy, Cogeneration, Turbomachines, Optimal Management of Bio-Economic Systems, with a strong focus on Hybrid and Solar Vehicles in the last decade.
Gianfranco Rizzo always believed in the potential of young generations and in intercultural exchanges, and tried to express these values through a remarkable career, filled with international cooperation and projects involving university students, both from engineering and management majors.
His unceasing publishing work (more than 150 between papers and articles) has always been backed by the motivation of providing his students with the most advanced knowledge available at the time.

The first, practical need of the research group was to have a real vehicle to work on, which was obtained in May 2006: a Porter Micro-Vett, an electric vehicle to be used as basis to develop a new prototype of hybrid solar vehicle with series structure (*See Exhibit [1] for a picture of the vehicle and some details about the project*).

The team was now able to proceed and start the development and testing phase. One of the biggest struggle during the initial months was to manage the tension between quality and precision and the

need of getting things done as quickly as possible, in order to be able to gain visibility and, eventually, further funds to go on.
After months of intense work, the research group was able to present the first prototype of Hybrid Solar Vehicle at Odeon TV, a local TV channel, in January 2007 (*See Exhibit [2] for Hybrid Solar Vehicle and HySolarKit media presence).*

The project itself and the issue of hybrid solar vehicles, in the meantime, were getting increasing traction among the academic and the engineering environment. In 2007, a series of projects and collaborations was implemented, like the 2nd International Workshop on Hybrid and Solar Vehicles and the two-year research program "Integration of Photo-Voltaic Systems in Conventional and Hybrid Vehicles", financed by the Italian Ministry of University and Research (MIUR) and coordinated by DIMEC of University of Salerno in cooperation with DIIIE (University of Salerno) and DIEES (University of Catania).
In the same year, the project – still in the development phase - gained popularity within the sustainable mobility scene and got to be presented during conferences, conventions and events *(See Exhibit [3] for a comprehensive list of the events attended by the research group).*

Thanks to the increased visibility and exposure, the research group benefited from the funds granted by new sponsors: CIMEP and CRF (alongside with Automobile Club Salerno, Lombardini, FIAT Research Center, and Saggese). This new injection represented a strong boost in morale and, by August 2007, the first version of the prototype was completed, including a new single-cylinder generator group. At the same time, an advanced version of a dynamic Hybrid Solar Vehicle simulator was launched online.

Regarding this prototype, the first choice was about deciding to build a new vehicle or to use the product to equip an existing car. Because of time and budget constraints, the second option was preferred. The first prototype adopted the “Series Hybrid Vehicle” configuration (For further details look at the industry analysis). The layout was assembled on a porter glass van provided by one of the sponsors and many small and relatively cheap panel were installed on the moderately large space offered by the roof of the van. A first kind of motor generator had to be rejected because of problems with the voltage and a second, less powerful one, was chosen for the prototype. Nevertheless, in the first version there were also some acoustic insulator problems that were only partially addressed *(See Exhibit [4] for the technical characteristics of the prototype)*.

HySolarKit – The product

Building on the ideas stemming from previous years and on macro-trends analysis, in 2010 the research group came up with HySolarKit. The project focuses on the development and production of a kit (which includes equipment, associated techniques and methodologies) to be sold in the after-market and aimed at converting conventional cars into hybrid solar vehicles, thus reducing fuel consumption and emissions without affecting performance and safety. Mild-solar-hybridization is performed by installing in-wheel electric motors on the rear wheels (in case of front wheel drive) and by the integration of photovoltaic panels on the roof; the panels have been supplied by Enecom, but - starting from 2015 - the company planned to source them from Solbian, its partner in Phase 2 of the H2020 Project. The original architecture is upgraded with a storage device (battery pack) and an additional control unit to be faced with the engine management system by the OBD port, not interfering with the original engine control unit.
The kit could potentially be applied to the majority of existing vehicles, specifically front-wheel drive cars. Its feasibility has been assessed by a project financed by the Italian Ministry of Research (*See Exhibit [5] and Picture [6] for technical details).*

The team strongly believed in the integration of hybrid and electric vehicles with solar energy, which, through on-board photovoltaic panels, can provide an important contribution to reducing both fuel consumption and CO_2 emissions: during sunny days, photovoltaic energy can contribute up to 30% of the overall energy requested for vehicle traction (when vehicles are used for approximately one or two hours per day in urban areas). Moreover, photovoltaic costs are constantly decreasing, whereas, thanks to the continuous research efforts, electrical efficiency is growing. Currently, high-efficiency (18%) flexible single-crystal silicon HF65 (ENECOM) photovoltaic panels have been installed on the vehicle's roof and hood, for a total of about 270W of installed power.

However, many criticisms arising from the automotive community argued that limitations were as evident as potential benefits. The most serious one, concerning direct automotive use, was energy density, i.e. the amount of radiation theoretically incident on Earth surface - about 1360 W/m2: indeed, only a fraction of this energy can be converted as electrical energy to be used for propulsion. Considering that the space available for PV panels on a normal car is limited, it follows that the net power achievable by a solar panel is about two order of magnitude less that the power of most of today cars.

While this argument could sound reasonable, it is based on the misleading habit to think in terms of power, rather than in terms of energy. In fact, for a typical use in urban driving (no more than one hour per day, with an average power between 7 and 10 kW, considering a partial recovery of braking energy), the net energy required for traction can be about 8 kWh per day, while a PV panel of 300 W can operate not far from its maximum power for many hours, if properly located and controlled: in these conditions, the solar contribution can represent a rather significant fraction, up to 20-30%, of the required energy.

See Exhibit [7] for an exhaustive timeline of HySolarKit history and Exhibit [8] for a map of the project presentations around the World.

Implementation – eProLab and eProInn

The implementation of the project occurred through the Energy and Propulsion Laboratory (eProLab), gathering academic professors and students from the Industrial Engineering Department of University of Salerno. The Lab focuses on empirical research (its main fields include internal combustion engines, hybrid and hybrid-solar vehicles, fuel-cells, energy conversion systems, renewable energy plants and energy planning) and on the management of external relationships with potential partners or investors.
The activity of eProLab has been increasingly noticed and valued by the engineering and automotive community, which provided many prizes and awards to its work on the integration of hybrid vehicles and solar energy. The first one was the H2Roma 2010 Award, granted to Gianfranco Rizzo for the paper "Effects of Engine Thermal Transients on Energy Management of Series Hybrid Solar Vehicles", published on Control Engineering Practice in November 2010.
See Exhibit [9] for a comprehensive list of the awards received by eProLab and HySolarKit and Exhibit [10] for a list of the main partners of eProLab over the years.
In 2011, eProLab obtained PCT extension for HySolarKit patent (*See Exhibit [11] for the patent).*

May 2014 has been an important month for eProLab. For what concerns external relationships and visibility of the project, it managed to participate in the Horizon 2020 context, getting the chance to seek partnerships with Bertone, LandiRenzo and Enecom (*See Exhibit [12] for a list of the Horizon 2020 participants*).
Regarding the industrialization of its projects, it launched Energy and Propulsion Innovation

(eProInn), a spin-off company focused specifically on the industrial development of laboratory projects – especially eProLab projects and HySolarKit, in its early stages. Since its launch, the HySolarKit project has gained the attention of the national press.
[Articles]

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The activity of eProLab is positioned at the intersection between three different areas of research: solar energy, sustainable mobility and hybrid cars.
The case provides an individual analysis of each of these sectors, with a special consideration for the conditions in Italy, where the project started and is being developed.

Solar energy and solar panels

Solar Energy Industry can be segmented both by Technology and by Application, resulting in four main segments, easily representable through a matrix framework (*See Exhibit [13] for the matrix segmentation of Solar Energy Industry*):

1. Residential Photovoltaic (PV). How does it work? Photons in the sunlight are absorbed by semiconductors, causing electrons to move (this is currently electricity). Electricity is then converted from DC to AC and is either used immediately, stored in a battery or sent back to the utility grid. The process generates electricity.
2. Photovoltaic (PV) as a utility.
3. Solar Heating and Cooling (SHC). These low and medium temperature collectors do not generate electricity; instead, they heat the liquid used to heat or cool a home or building (e.g. solar water heaters, solar pool heaters, and solar cooling, which uses heat to create air-conditioning).
4. Concentrating Solar Power (CSP): concentrated sunlight heats a fluid that drives a turbine to generate electricity.

Distributed solar capacity is predominantly photovoltaic (97.6%), while utility capacity is CSP and PV. The top-three producers of solar PV capacity in the world in 2014 were Germany (21.6%), China & Taiwan (16.4%) and Japan (13.2%), while the rest of Europe accounted for 14.5%; Germany was, in 2006, the first European country to introduce incentives for PV energy, through a feed-in tariff system.
A SEIA 2009 study comparing solar energy with more traditional generation technologies, shows that solar is increasingly competitive, almost always less expensive than new peaking plants and increasingly less expensive than new baseload (*See Exhibit [14] for a graphic comparison*).

Solar panels belong to the PV distributed segment. Providing some definition might prevent confusion and misunderstandings: a *solar module* is an individual solar panel, consisting of multiple solar cells, wiring, a frame and glass; a *solar array*, instead, is a group of solar modules connected to the same system (*See Exhibit [15] for the functioning of a solar module*). There are three general families of photovoltaic solar panels: monocrystalline and polycrystalline (belonging to the traditional technologies for solar panels) and the newer thin film. *See Exhibit [16] for a detailed description of the three families.*

For what concerns the solar equipment manufacturing business, Chinese companies (Trina Solar and Yingli Green Energy take the first two places, with six Chinese companies in the first 10 spots) lead World rankings.

Looking specifically at Italy, where HySolarKit was born, a positive outlook can be observed: in April 2015, solar energy accounted for 11% of the energy consumption in the country (pushed by the positive trend of renewables in general, accounting for 38% of the total in 2014) and was present in 100% of the 8'047 Italian municipalities.
Today, Italy is the first country in the world by incidence of solar energy with respect to electric consumption and it is witnessing a sharp decline in fossil fuel imports and in cost of energy production. Conditions are extremely favourable for the emergence of solar energy in Italy: indeed, the country lacks energy sources but is abundant in solar radiation; moreover, solar plants are being increasingly integrated with smart grids or storing systems, one of the recently emerging trends.

Sustainable mobility

Mobility itself is defined as the ability of people and goods to move or be transported. A *sustainable development* is a development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Therefore, *sustainable mobility* – as defined by the World Business Council for Sustainable Development – is the mobility that meets the needs of society to move freely, gain access, communicate, trade and establish relationships without sacrificing other essential human or ecological requirements today or in the future. Within this context, a *sustainable transport system* is one that enables individuals and societies to satisfy their needs for access to activity areas in complete safety, in a way that is compatible with the health of mankind and ecosystems, and which is also fairly balanced between different generations: it is a system that will come with reasonable costs, that will operate efficiently and that will offer all populations a choice between different transport alternatives.
The previous definitions stand on a set of principles that should provide a framework for policy makers and planners: preserve the natural environment; maintain human health and safety; meet the travel needs of the population; support a good economy; minimize transport costs for access and mobility; minimize infrastructure costs; maintain energy security; ensure long-term viability of the transport system.

In the last years, sustainable mobility has become a major issue for transport, since transport is a key driver in attempt to increase the degree of sustainability in our societies, and for our local authorities. It has a direct effect on all the negative impacts that can be measured: environmental impacts, social impacts, economic impacts. The biggest *social challenges* are represented by accessibility and fairness across society as a whole (e.g. accessibility for the elderly); quality of life in city areas, quality of life of commuters and people's autonomy (it is hard to measure the value of autonomy); isolation and segregation. *Environmental challenges* can be identified more easily, since individuals are far more sensitive to causes like air pollution or greenhouse gases production; however, there are other environmental aspects to be taken into account: consuming space, number of parking places needed by a vehicle, fragmentation of habitats, water run-off, air quality, noise pollution. Finally, *economic aspects* are easy to spot but hard to control; some of them are transport costs affordable for everyone, contribution made by all the employment linked to the transport systems, collective investments and collective budget devoted to transport.
As a subject at the heart of transport strategies, several countries and regions have equipped themselves with tools, policies and action plans in a bid to focus the decision making in transport-related matters to try to improve the level of sustainability.
See Exhibit [17] for an overview of vehicle demand management around the World.

Sustainable mobility can be improved by acting from two different sides:

a. *Supply* of transport, which implies to try and modify behaviours. For example, by investing in infrastructures (even though that can produce various non-intuitive effects); by taking financial measures, for example tolls, pricing structures and car parking management; by reducing supply, for example limiting the potential usage of vehicles that have lower levels of sustainability.
b. *Demand*: either in terms of communication, by making people aware of the negative impacts of their transport choices; or in terms of urban development and time management policies (for example, changes in timetables, support to home-working).

The sustainable mobility field has recently gained attention and funds, and therefore witnessed the emergence of many trends. Some of the most used tools, nowadays, are: bike and car sharing, congestion pricing, low emission zones, Google Transit web apps, vehicle quota systems, urban design for access.
See Exhibit [18] for the evolution of these trends over time.

Car manufacturers tried to take on the problem lowering the environmental impact of the vehicles that they produce. This goal was pursued with the development of more efficient engines in order to lower the emissions and fuel consumption. Moreover, another relevant initiative consist in the development of vehicles that exploit different kind of fuel that are less polluting and cheaper like the LPG and the methane or electric and hybrid vehicles.

Over time, other companies in the automotive industry tried to face the problem by providing kits for gasoline-fuelled cars, that convert traditional fuels to others (i.e. from gasoline to LPG).

Hybrid cars

A hybrid vehicle is a vehicle that rely on two or more distinct power sources to move. The term commonly refers to hybrid electric vehicles (HEVs), which combine an internal combustion engine (using a variety of fuels) and one or more electric ones. In these vehicles, the energy is stored both in the fuel of the internal combustion engine and in battery sets.

Despite the common thinking of hybrid cars as a recent phenomenon, their history started over 100 years ago when Ferdinand Porsche built the first one, in 1899. However, Ford's first automobile assembly line (1904) allowed the production of gasoline-powered cars at a substantially lower price and higher power: this was the start of a nearly 50-year period during which hybrid cars did manage to hardly claim any interest.
The introduction of a United States congress legislation that encouraged the use of electric vehicles in the 1960s aimed at reducing pollution and the oil crisis in the 1970s contributed to renewing the interest in the sector. Nonetheless, despite the millions of dollars spent by auto manufacturers on research and development of hybrid technologies, very few vehicles were produced until the 1990s.

The first vehicle that seemed to be really able to provide a viable alternative to oil powered vehicles was Toyota Prius, released in Japan in 1997 and in the United States in 2000. The Prius can be considered the most popular hybrid vehicle ever produced and its technology has been used to develop several other vehicles from different auto manufacturers to produce models like the Porsche Cayenne, the Chevrolet Volt and the Ford Fusion.
The current era, characterized by an increasing environmental awareness, boosted the interest in this business, with more and more auto manufacturers introducing new models of HEVs. Another factor that enhanced the interest in hybrids was definitely the technology itself: thanks to its continuous improvements, it allowed the production of progressively cheaper and more reliable vehicles, with improving performances too.

The “plug-in hybrids”, for example, have larger batteries and can recharge their batteries from an outlet, allowing them an extended usage. These models can drive entirely on electricity at relatively high speeds for extended distances (typically 10 to 30 miles). *See Exhibit [19] for a detailed explanation of how a plug-in hybrid works.*

The main hybrid layouts are:

- *Series hybrids*, characterized by electric motors that turn the drive wheels. These layouts are the oldest and these vehicles are not "pure" electric vehicle; indeed, they have a dedicated engine that burns fuel and expels emissions and the motors must be large and powerful.
- *Parallel hybrids*, currently the simplest and least costly ones. In these layouts the output of the engine and the electric motor operate together upstream of the transmission, with the main contribution coming from the engine. The electric motor, besides providing an extra boost, can propel alone the car for short distances.
- *Series-parallel hybrids* contain elements of both types, enabling fully independent propulsion via the engine or electricity. The engine can still power the car, but it can also charge the battery while the electric motor drives the vehicle. In these vehicles, a computer monitors the driving conditions and the state of the battery, choosing which mode is most efficient at any given moment. Despite an excellent payoff in efficiency, these layouts are more expensive.

Different technologies stand behind HEVs and offer different advantages and disadvantages. Some of the most common are:

- Electric Motor Drive/Assist: this "power assist" feature provides additional power in accelerating, passing, or hill climbing. Furthermore, it allows the usage of a smaller and more efficient engine with the system’s total power, which can equal or exceed the one of a conventional vehicle.
- Regenerative Braking: differently from conventional cars, which dissipate the kinetic energy of the breakings, this technology allows to capture some of that energy and store it in the batteries until needed by the electric motor. Nevertheless, this technology is insufficient to stop a car quickly, so conventional hydraulic brakes are still necessary.
- Automatic Start/Shutoff automatically shuts off the engine when the vehicle is stopped and restarts it when the accelerator is pressed, thus preventing wasted energy from idling. This system can offer 3-10% increases in fuel efficiency and is expected to become almost universal.
- Batteries. Currently, hybrids employ two battery types: Nickel-metal (NiCad) and Lithium-ion batteries. NiCad batteries are used in the majority of current hybrids but present some drawbacks; indeed, they do not charge as well or as fast as other battery types, and are heavy too. Lithium-ion batteries - lighter and more energy-dense - are increasingly used on newer hybrid models. R&D departments spend considerable efforts on this component.

The use of the vehicle on electric power alone gives the most efficient use of the hybrid system and it is possible if it has enough electrical capacity. The speed and distance over which this mode is supported vary depending on several factors (i.e. weight and aerodynamics of the vehicle, strength of the motor-generator, battery’s capacity). Finally, for the HEVs that cannot be plugged-in, electric-only drive is typically only utilized at low speeds and start up, while the engine operates at higher speeds, where it is most efficient.

HySolarKit positioning

HySolarKit stands in the middle of these different areas, providing the project with a unique perspective. Indeed:

- The main goal of the project is to take on the problem of the sustainable mobility trying to act on the supply side while leveraging a need on the demand side.
- The link with the hybrid cars is provided by the fact that the function of the kit is to transform an existing, polluting and fuel inefficient car in a HEV.
- Finally, the solar panels are a key component of the project, since they are the mean by which HySolarKit helps propelling the car, by harnessing the renewable energy provided by the sun.

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After the initial financial struggles, during which Gianfranco Rizzo sometimes feared the project would have never seen the light, eProLab had managed to develop a sound prototype and to gain international recognition, among the experts and the academics of the sector.
Thanks to his experience - both in the corporate and university worlds -, however, Gianfranco Rizzo knew that they still had a long way to go and that further challenges were still to be faced. The tricky phases of commercialization – in the shorter term – and scaling – in the medium term – were still to be implemented, and eProInn was working relentlessly in order to figure out the best approach to them.

Commercialization

In its broadest meaning, commercialization is the stage in the product development process where the decision to order full-scale production and launch is made. Shortly, this is the phase in which a new product is introduced into commerce and made available on the market – either by entering the mass market from a niche market or by moving from the laboratory into commerce.
Commercialization allows inventors and innovators to realize and monetize the benefits of knowledge, therefore receiving returns on previous investments in education, training, R&D and relationships with stakeholders; at the same time, in exchange for money, it makes technology available to end users.
The definition provided by Pellikka and Malinen (2011) well summarizes the meaning of this word within the technology sector: commercialization brings high-technology innovations to the market and makes innovative products benefit of society.

Commercializing HySolarKit involved answering some key questions that could better define the target market and the mode of entry like:

1. *Whom to target?*
2. *Where to launch?*
3. *When to launch?*
4. *How to launch?*
5. *Which was the most suitable marketing strategy?*

Moreover, other issues concerned Gianfranco Rizzo and his co-workers: had stakeholders been involved enough? Was a partnership with the public sector desirable?

Scaling

Commercialization implies defining and implementing the sales model in the short term. In the medium-term, the scaling phase usually implies: focus on growth, choice of KPI's, growth in number of users, customer revenue growth and/or market traction in a big or fast growing target market. At the scaling stage, the company has to or already did attract significant funding. Scaling normally happens after product-market fit has been found and the search for a repeatable sales or customer acquisition model has yielded enough positive data.
In order to successfully scale-up, management needs to address issues like:

1. *Can the product operate at scale?*
2. *Will the company be able to market the product at scale?*
3. *Is the team suitable for scaling?*
4. *How to scale?*

Like commercialization, moreover, scaling poses significant challenges, as it results from the careful management of the risks of premature scaling and late scaling. In fact, empirical research identifies wrong scaling as the number one reason of start-ups' death.

At this point, eProLab has to analyze the characteristics of potential suppliers and partners along the supply chain, in order to identify the most suitable ones. Moreover, an adequate set of KPI's is primarily important, to better define and track the scaling process.

Conclusions

As soon as Gianfranco Rizzo left his accordion, he realized that crucial elements to make HySolarKit successful were the speed and the effectiveness of his following choices. Despite being still unsure about what to do, the professor decided that he would have set a meeting for the next week with the other members of eProInn in order to define the next steps.

How would you advise Gianfranco Rizzo about the future of HySolarKit, considering all of the information that you can extrapolate from this case?

APPENDIX

Exhibit [1]: The first prototype.

Exhibit [2]: Media presence of Hybrid Solar Vehicle and HySolarKit.

Articles:

- 02/2006 - Quattroruote - Progetto Sole
- 09.07.2012 - Il corriere della sera - Premio Best Practices - Vincono le auto ad energia solare
- 30.06.2012 - Il Denaro - Economia - Innovazione
- 01.12.2010 - Hy Solar Kit su "Nova" de "Il sole 24 ore"
- 01.12.2010 - Un articolo de La Repubblica, che cita le ricerche dell'Università di Salerno sui veicoli ibridi a ricarica solare.
- 04.12.2010 - Il Denaro: L'auto del futuro è targata SA.
- Quattroruote: le ricerche sui veicoli ibridi solari all'università di Salerno
- 10.06.2013 - L'Espresso: intervista a G.Rizzo nell'articolo "L'auto è diventata verde"
- 16/09/2013 - Costozero - HySolarKit: trasforma la tua auto in un veicolo ibrido solare
- 12/12/2013 - La città - Un kit per trasformare un'auto normale in ibrida
- 23/01/2014 - Il Mattino - L'auto alimentata dal sole - Il Campus batte la FORD
- 12/02/2014 - Il Denaro - Polo Mobidic nel Vallo di Diano - Mobilità sostenibile firmata Bertone
- 19/02/2014 - La Repubblica - E la vecchia auto diventa vettura ibrida
- 06/03/2014 - Il Corriere del Mezzogiorno - Style Auto - A Salerno la benzina è il sole

25/04/2014 - La Stampa - Metti il sole nel motore. E la vecchia auto diventa EURO 5 - Nasce l'ibrido-solare

20/05/2014 - Il Mattino - L'auto elettrica per tutti. Il kit di montaggio costruito all'università di Salerno

05/07/2014 - Corriere della Sera - Faccia a faccia tra startup e big

11/2014 - Science et vie - Un kit promet de convertir toute voiture à essence en hybride solaire

Online articles :

eco|blog - Salerno: non più auto elettrica ma veicolo ibrido solare.

indipedia: Salerno: non più auto elettrica ma veicolo ibrido solare

::trasformateria:: Veicolo ibrido o quasi

DOMUS Energia - Il primo veicolo ibrido solare made in Italy

upnews - E' salernitano il primo veicolo ibrido solare

L'Italia che funziona: il Kit solare ibrido per auto realizzato dall'Università di Salerno

BuoneNotizie.it: HySolarKit: il kit italiano che trasforma un veicolo in ibrido-solare

TechnologyBiz - Da Salerno: HySolarKit, il kit per trasformare in ibrida qualunque vettura

Daily e - Come trasformare un autoveicolo in un veicolo ibrido solare - di Nicoletta Gentile

EdilCamp - HySolarKit, la macchina è solare

La nota positiva - L'innovazione italiana inventa il futuro

WIND Business Factor - HySolarKit è un kit per convertire una auto in un veicolo ibrido-solare

HySolarKit: il kit italiano che trasforma un veicolo in ibrido-solare

www.pintegraf.com

HySolarKit, invenzione made in Italy per alimentare l'auto con energia solare

Il sole a 4 ruote, da Salerno il kit che fa risparmiare sulla benzina

Metti il sole nel motore. E la vecchia auto diventa EURO 5

Trasforma la tua auto in un veicolo ibrido solare

Trasforma la tua auto in un veicolo ibrido solare

HySolarKit, il progetto del DIIN finisce su Rai2, di Maria Cristina Folino

Va avanti il progetto Hy Solar Kit: intervista al prof. Gianfranco Rizzo

Salerno sforna il Kit Trasformazione auto elettrica – Makin' Blog

UNIVERSITÀ DI SALERNO: UN SEMPLICE KIT E L'AUTO DIVENTA ELETTRICA

Nasce l'auto che fa il pieno col sole

Un simple kit et la voiture devient électrique

Je passe à la voiture électrique

UNE VOITURE ÉLECTRIQUE EN UN KIT!

Un simple kit et la voiture devient électrique

Seminario su H2020: Come partecipare con successo allo SME Instruments

TV and Radio:

- January 2007: A new prototype of Hybrid Solar Vehicle presented at Odeon TV, in Italy
- March 2007: TV Program 'Rondò' transmits a video of the prototype, as long as interviews to the participants to the workshop on 'Hybrid and Solar Vehicles'
- June 2007: '1st Senigallia Solar Rally' transmitted on Radio 2
- December 2013: Interview at Radio Capital
- March 2014: the project gains the attention of the national press, through articles on La Stampa, La Repubblica, Il Corriere del Mezzogiorno, Il Mattino, La Città (among the major Italian newspapers)
- May 2014: the project is presented in the 'Sereno Variabile' TV Show on one of the most important national channels
- January 2015: HSK appears in some scenes of the movie 'Asphyxia' by Alessandro Angeli
- January 2015: 'Science et Vie', renowned French science magazine, writes about the project in one of its articles. HSK also received the attention of many other French websites
- March 2015: Radio24 talks about HSK
- September 2015: Gianfranco Rizzo, head of the HSK project, has been invited to discuss the recent VW scandal at the national radio station Radio24
- September 2015: 'Platinum' magazine publishes a long article on HSK

Exhibit [3]: A comprehensive list of the conferences, conventions and events attended by the research group in the phase preceding HySolarKit.

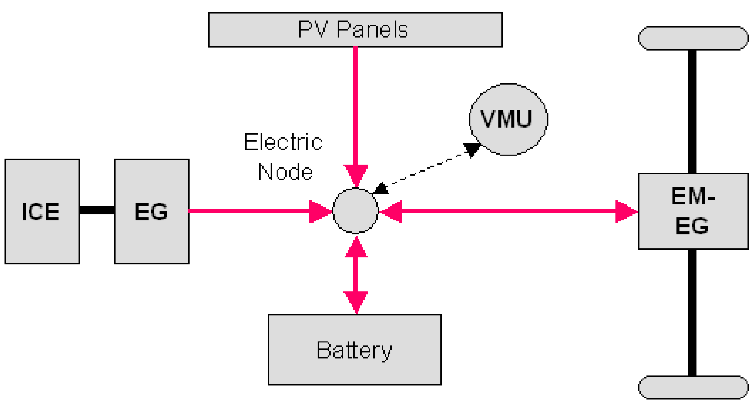
- ***March 2007***: Prototype of HSV presented at the exposition Energy-Med, in Naples and within the workshop on 'Air Quality and Vehicle Emissions' held by Provincia di Napoli.
- ***May 2007*****:** Prototype presented at 'Terrafutura' in Florence.
- ***June 2007***: The hybrid solar vehicle participates to the '1st Senigallia Solar Rally'.

- ***October 2007***: The Hybrid Solar Vehicle prototype developed at the University of Salerno within the project 'Energy Conversion Systems and Their Environmental Impact' participates to 'ECOTARGA & GREEN PRIX', the first edition of the historical 'TARGA FLORIO' dedicated to ecological vehicles, to be held in Sicily. Among the participants, NUNA3, the winner of World Solar Challenge 2006. Outcome: satisfactory result, in spite of very bad weather. The vehicle, conducted by the driver Raffaele Di Martino, scored three points in the FIA table and a satisfying sixth position on regularity test, over 13 participants (the top five position have been held by five Toyota Prius, the unquestioned stars of the ecological vehicles).
- ***November 2007***: Prototype presented at Ecomondo/KeyEnergy in Rimini.
- ***April 2008***: Prototype presented at "Ambientarsi", in Salerno.
- ***2008*** - New project proposal: Hy_Solar_Car is the title of a proposal of a new project within the LLP - Leonardo da Vinci - Transfer of Innovation, submitted to the European Commission, with the participation of 17 partners of 5 European countries.
- ***November 2009***: Two prototypes developed at the University of Salerno at "Motor Show", in Bologna (participation sponsored by Magaldi, Salerno Energia, Antonio Amato, DIMEC, UNISA Automotive Group):
    - A Hybrid Solar Vehicle, developed within the Leonardo Project "Energy Conversion Systems and Their Environmental Impact"
    - A prototype of racing car, developed by UNISA RACING TEAM within the Formula SAE/ATA

Exhibit [4]: Technical characteristics of the first 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**. Although 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 electric vehicle** was chosen as basic structure for prototype development.

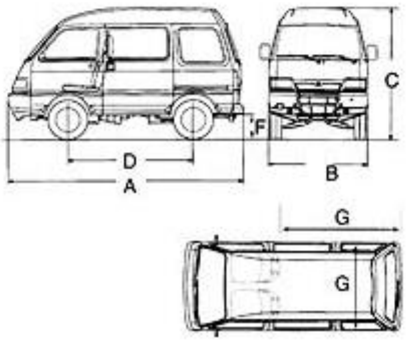
The structure: A **"Series Hybrid Vehicle"** configuration seems to be the most suitable solution to match the framework chosen. In this case, traction power is supplied only by the electrical motor (EM/EG), which may operate also as generator during braking mode (regenerative braking), adopting one of the electric vehicle energy recovery strategies. 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.



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. The electric motor may be reached lifting driver seat.

Electric vehicle technical characteristics:

Sizes	Meters
A	3.560
B	1.395
C	1.870
D	1.810
F	0.540
G	0.793



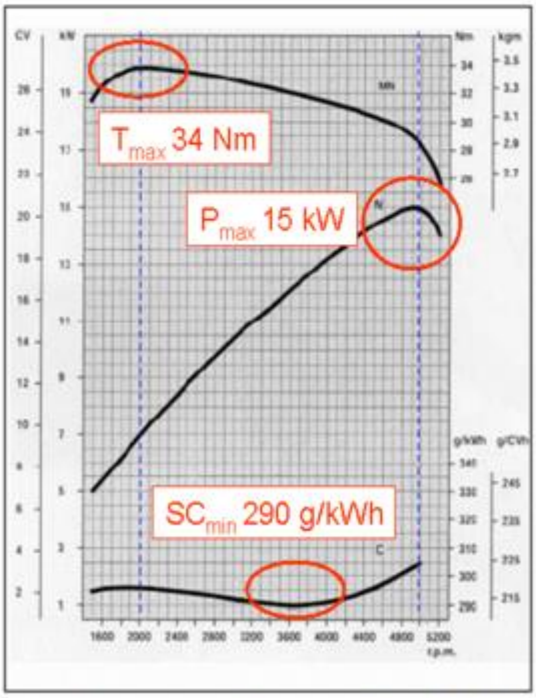
Engine	Direct Current Motor
Voltage	84 V
Nominal power	9 kW
Cooling flow	Air
Battery pack	14 6V modules - 180 Ah Pb-Gel sealed, without maintenance
Battery charger	On board - 3 kW - 230 V (standard industrial monophasic plug)
Charging time	8 h
Rapid charging	5 kW - 380 V
Rapid charging time	2 h 45' @ 80% State of charge
Maximum speed	60 km/h
Range	70 km in urban duty cicle
Transmission	Direct to the rear axle
Steering radius	3,7 m
Seats	4

Photovoltaic panels:

- **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 Company and donated to the research group.

The motor/generator system: Firstly, we have tried to use a motor-generator system offered by Lombardini: a 15 KW two-cylinder gasoline engine water cooled. A solution characterized by a favourable power to weight ratio, by limited sizing and power level adequate to vehicle demand.

Scheme of the Lombardini motor-generator system



Torque, power and specific consumption of Lombardini group

Lombardini 500cc LGW523 ENGINE
Max power 15 [kW] @ 5000 [rpm]
3 phase induction MACHINE 15 [kW] power rated
0 - 6000 [rpm] speed range
200 - 400 [V] DC voltage range
100 [A] DC max current

Lombardini Motor-Generator - Technical Data

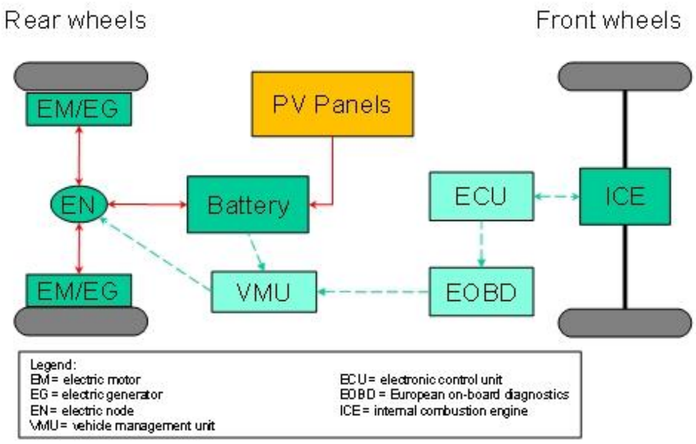
In order to remove the heat generated by the cooling system, the original radiator used on the vehicle has been recovered and mounted, at CIMEP laboratories. Moreover, intake air inlet and exhaust gas discharge outlet have been realized.
Additional problems:

- The output voltage was higher than the one needed to charge the batteries;
- Electric generator power was higher and not compatible with the circuits already mounted on board;
- The electric machine needs a complex control system to work as motor during start-up and to shift to generator mode after thermal engine start.

The second motor/generator: The solution of these problems did not appear compatible with the time scheduling of the project. Therefore, a second solution has been chosen: a 6 KW YANMAR S6000 single-cylinder Diesel engine, air cooled, with electric starter. This generator, although less powerful respect to Lombardini, allowed to overcome the problems cited in 1, 2, and 3. In particular, the electric output, at 230 V, was directly linkable to the vehicle circuitry. The YANMAR has been soon renamed **"o' per e o' muss"**, thanks to its similarity with the groups used by the street vendors of the famous Neapolitan speciality. The group has been mounted on the back trunk, using the mechanical supports and the apparatus already available on board. It has been necessary to disable a security block that was preventing battery recharging when the vehicle was moving. Therefore, the engine start has been automated and suitable potentiometers have been mounted on gas and brake pedals.

Noise: Of course, mounting a motor-generator into the passenger compartment is not precisely the best solution in terms of comfort (and safety). Therefore, an **acoustic insulator** has been designed and 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, with lead thin layer and a sponge rubber, to cut low and high frequencies. In this way, a satisfying **noise reduction** has been obtained.

Exhibit [5]: HySolarKit – How the prototype works.



The hybridizing equipment is installed on a **conventional car** (two front wheels drive), in which the **front wheels** are propelled by the Internal Combustion Engine (ICE) controlled by an Engine Control Unit (ECU). The vehicle is also equipped with an EOBD gate (On Board Diagnostics protocol), which allows accessing data such as pedal position, vehicle speed, engine speed, manifold pressure and other variables. A **mild parallel hybrid structure** is obtained by substituting/integrating the **rear wheels** with **in-wheel motors**. In that way, the vehicle can operate in pure **electric mode** (when ICE is switched off or disconnected by the front wheels) or in **hybrid mode** (when the ICE drives the front wheels and the rear in-wheel motors operate in traction mode or in generation mode, corresponding to a positive or negative torque). The battery can be recharged both by rear wheels, when operating in generation mode, and by **photovoltaic panels**. The **Vehicle Management Unit** (VMU), which is part of the invention and implements control logics **compatible with typical drive styles of conventional-car users**, receives the data from **OBD gate**, from battery (SOC estimation) and drives in-wheel motors by properly acting on the electric node EN. A display on the dashboard may advice the driver about the actual operation of the system.

HySolarKit, to be installed for converting a conventional car into a hybrid solar vehicle, will include:

1. A couple of in-wheel motors, which can be purchased (they are currently commercialized by Michelin and other manufacturers) and eventually modified according to system requirements.
2. An auxiliary battery pack, presumably consisting of Lithium-Ion cells.

3. An additional control system (VMU), which is conceived to be self-adaptive enough to be suitable for different vehicle and in-wheel typologies and features.
4. A connector for the OBD gate along with related cables, to be connected to the VMU.
5. Either a flexible or semi-rigid solar panel, to be installed on vehicle roof.
6. Possibly, a small additional display to be placed on car instrument panel, which could include a state of charge indicator for the auxiliary battery along with additional control buttons to switch from one operating mode to another.

Picture [6]: HySolarKit applied to a FIAT Punto

Exhibit [7]: HySolarKit Timeline.

2010	
Feb 2010	Italian Ministry of University and Research funds the project "Modeling and development of a prototype to enhance conventional vehicles with hybrid features", coordinated by University of Salerno in cooperation with University of Sannio
May 2010	Project is presented at the BIPResearch, held in Milan, Italy
	Publication of a book chapter on hybrid solar vehicles in the book "Solar Collectors and Panels, Theory and Applications"

2011	
Jul 2011	"Solar energy for cars: potentialities, limits and research topic" given by G.Rizzo at the 2011 International Forum on Advanced Vehicle Technologies and Integration (VTI 2011), Changchun, China
Aug 2011	HySolarKit patent obtains international PCT extension
Sep 2011	The paper "G.Rizzo, M.Sorrentino, C.Speltino, I.Arsie, G.Fiengo, F.Vasca (2011), Converting Conventional Cars in Mild Hybrid Solar Vehicles", is presented at the 2011 IFAC World Congress and published in the Preprints of the 18th IFAC World Congress, in Milan, Italy
Sep 2011	The paper "M Sorrentino, G Rizzo, F Vasca (2011) An Energetic Comparison for Hybrid Vehicles Ranging from Low to High Degree of Hybridization" is presented at SAE ICE2011 and published in the Proceedings of ICE2011 Conference, in Capri, Italy
Dec 2011	The paper "Analysis of a rule-based control strategy for on-board energy management of series hybrid vehicles" by M.Sorrentino, G.Rizzo, I.Arsie is published in Control Engineering Practice 19:: ISSN 0967-0661. 1433–1441 December

	2012
Feb 2012	Procurement of the in-wheel motors
Apr 2012	Procurement and testing of the equipment for the acquisition of vehicle data from the OBD port
May 2012	HySolarKit participates at Start Cup Campania 2012 contest
Jun 2012	Procurement of the FIAT Punto, used to test the solar hybridization kit
Jun 2012	HySolarKit is selected as on of the top ten projects within the contest “Il talent delle idee”, promoted by UniCredit. The entrepreneur idea was presented on Jun 1st, 2012 a the Employers’ Association of Naples
Jun 2012	The project HySolarKit is awarded with honourable mention for the environmental implications (motivation) within the 6th Premio Best Practices for the Innovation, organized by Confindustria Salerno (Employers’ Association of Salerno)
Jul 2012	Procurement and experimental characterization of flexible photovoltaic panels for the hybridization kit
Jul 2012	Sergi Molina and Oscar Lopez, Erasmus students from the University of Tarragona, discuss the thesis "Experimental study on photovoltaic panels for a kit of solar-hybrid conversion of conventional cars", advisors prof. Gianfranco Rizzo and prof. Giovanni Spagnuolo
Jul 2012	Simona Barberio, student in Management Engineering at the University of Salerno, discusses the thesis "The HySolarKit Case - Feasibility Study for the development of a solar hybridization kit for conventional vehicles’, advisors: prof. Mauro Caputo e prof. Gianfranco Rizzo
Sep 2012	Mario D'Agostino and Massimo Naddeo discuss two 2nd level theses in Mechanical Engineering on the HySolarKit project
Oct 2012	HySolarKit is selected as one of the top ten projects within the contest Start Cup Campania 2012
Nov 2012	Flexible photovoltaic cells are installed on the roof and hood of the prototype
Nov 2012	Final reporting for the PRIN Project "Modeling and development of a prototype to enhance conventional vehicles with hybrid features", coordinated by the University of Salerno in cooperation with the University of Sannio

	2013
Jan 2013	New in-wheel motor and integration with the rear wheels
Feb 2013	Electrified wheels installed on the FIAT Punto
Feb 2013	The chapter on "Hybrid Solar Vehicles", autori G.Rizzo, I.Arsie, M.Sorrentino ("Solar Collectors and Panels, Theory and Applications", book edited by Reccab Manyala, ISBN 978-953-307-142-8)
Apr 2013	Hebert Alonso Medina discusses the 2nd level thesis in Management Engineering on "A model to assess the benefits of an after-market hybridization kit based on realistic driving habits and charging infrastructure", advisors: Prof. Gianfranco Rizzo and Dr. Vincenzo Marano
May 2013	The paper "Analysis and Experimental Implementation of a Heuristic Strategy for Onboard Energy Management of a Hybrid Solar Vehicle", authored by G Coraggio, C Pisanti, G Rizzo and M Sorrentino, is published in Oil & Gas Science and Technology – Rev. IFP Energies nouvelles Vol. 68: 1. 13-22 May
June 2013	Installation of the hybridization kit control systemcompleted, in hybrid and electric modes. Preliminary road tests carried out at Fisciano campus
June 2013	Request of setting up a HySolarKit Spin-Off company approved by the Department of Industrial Engineering of the University di Salerno
Nov 2013	HySolarKit presented at Accademia dei Lincei and at TechologyBiz
Dec 2013	Horizon 2020 - Project Presentation and partner seeking

	2014
Jan 2014	The Board of the University of Salerno approves the set-up of a Spin-Off company to promote Hysolarkit
Mar 2014	HSK takes part in the Edison Start Challenge (within the Energy category) and in the project ‘Mobidic – Mobility Digital Center’, an integrated initiative in the sustainable mobility field, aimed at building a High Technology Transportation pole in the Campania region. The goal of the project is to produce Sustainable City Cars, create a Research & Innovation Center on Sustainable Mobility and a Theme Park on Sustainable Mobility
Apr 2014	Born of eProInn, a spin-off of the University of Salerno, aimed at industrially developing HySolarKit project
May 2014	Within the Horizon 2020 project, HSK explores partnerships with Bertone, LandiRenzo and Enecom
May 2014	HSK starts looking for potential financial partners at Borsa della Ricerca in Bologna, through eProInn
May 2014	HSK selected to participate to "Start-up Initiative", promoted by Intesa San Paolo
May 2014	HSK takes part in the initiative "Ecologicamente" (*Ecologically)*
May 2014	A wide reportage on HySolarKit is broadcast on RAI2 Sereno Variabile
May 2014	The crowdfunding phase of the project is announced

2015	
Jan 2015	Rong Tong Science and Technology Industry Group (from China) has committed to finance the development of a prototype of the kit, specifically for the Chinese market
Mar 2015	The project for the industrialization of HySolarKit passed Phase 1 of the Horizon 2020 SME Instrument selection. HySolarKit has been presented by eProInn, together with Actua and LandiRenzo and the consultancy of CiaoTech
May 2015	HSK presented at Technologybiz 2015, held in Naples
Sep 2015	HSK is proceeding towards Phase 2 of Horizon 2020. It also can benefit from the collaboration of Solbian, leader in the flexible solar panels sector. Moreover, some institutions from Malta expressed their interest in the project

Exhibit [8]: A map of the presentations held around the World, from 2006 on.

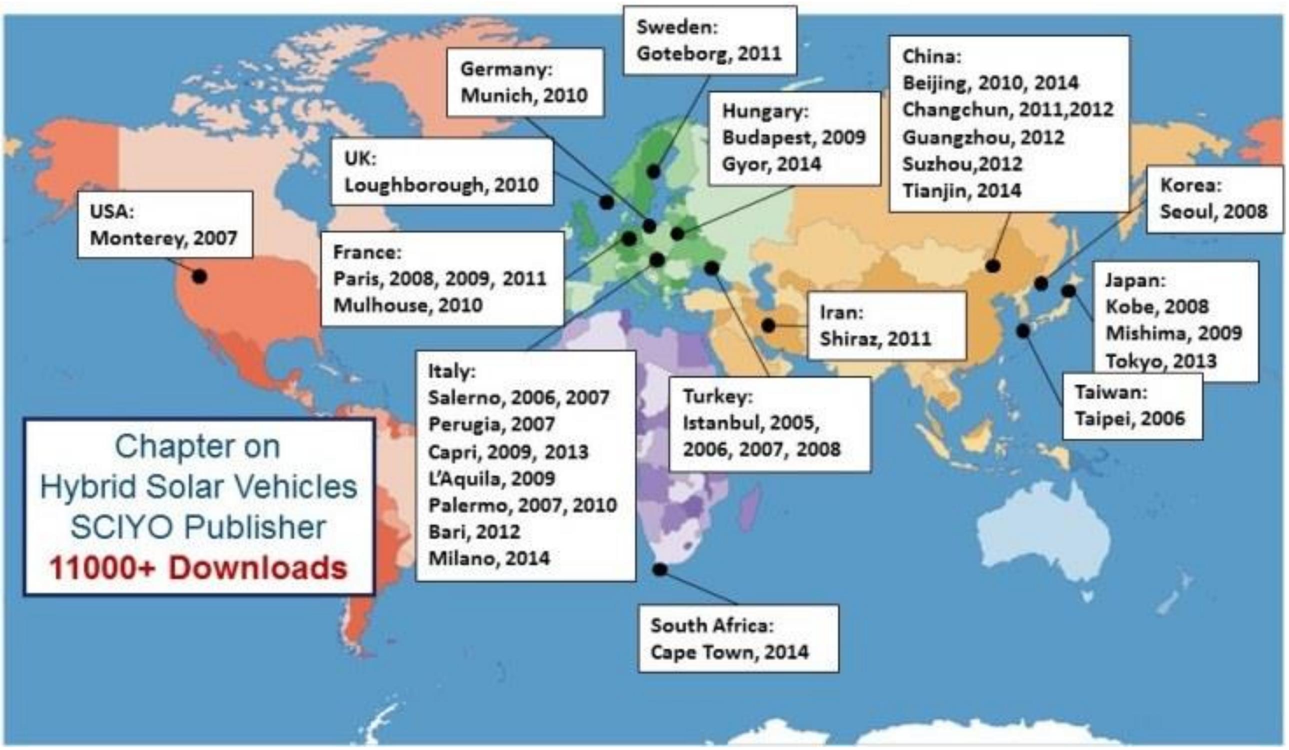


Exhibit [9]: Comprehensive list of awards and prizes received by eProLab and HySolarKit.

- *December 2010*: Award H2Roma 2010 for the paper: I.Arsie, G.Rizzo, M.Sorrentino (2010) "Effects of Engine Thermal Transients on Energy Management of Series Hybrid Solar Vehicles", published on Control Engineering Practice 18: 1231-1238 (Rome, November 9, 2010)
- *December 2010*: The European project on Hybrid Solar Vehicles "Energy Conversion Systems and their Environmental Impact", coordinated by the University of Salerno, selected as one of the ten best projects in terms of quality of dissemination and exploitation strategies, within the DiVa project
- *June 2011*: Prof. Gianfranco Rizzo receives in Sarzana, Italy, the "2011 Research and Innovation Award" for the research on hybrid solar vehicles
- *June 2012:* HySolarKit is selected as one of the top ten projects within the contest "Il talent delle idee", promoted by UniCredit and presented at the Employers' Association of Naples
- *June 2012:* The project HySolarKit is awarded with honourable mention for the environmental implications (motivation) within the 6th Premio Best Practices for the Innovation, organized by Confindustria Salerno (Employers' Association of Salerno)
- *October 2012:* HySolarKit is selected as one of the top ten projects within the contest Start Cup Campania 2012

Exhibit [10]: Main partners of eProLab over the years.

Exhibit [11]: HySolarKit patent, August 2011.

Pub. No.: WO/2011/125084 **International Application No.:** PCT/IT2011/000102
Publication Date: 13.10.2011 **International Filing Date:** 05.04.2011

IPC: ***B60K 6/52*** (2007.10), ***B60K 17/354*** (2006.01), ***B60K 17/356*** (2006.01), ***B60K 6/20*** (2007.10), ***B60K 6/22*** (2007.10), ***B60K 6/48*** (2007.10), ***B60L 11/18*** (2006.01), ***B60W 10/06*** (2006.01), ***B60W 10/08*** (2006.01), ***B60W 10/26*** (2006.01), ***B60W 20/00*** (2006.01), ***B60W 30/18*** (2006.01)

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Priority Data: RM2010A000161 07.04.2010 IT

Title **(EN)** KIT FOR TRANSFORMING A CONVENTIONAL MOTOR VEHICLE INTO A SOLAR HYBRID VEHICLE, AND RELEVANT MOTORVEHICLE OBTAINED BY THE KIT
(FR) KIT POUR TRANSFORMER UN VÉHICULE À MOTEUR CLASSIQUE EN VÉHICULE HYBRIDE SOLAIRE ET VÉHICULE À MOTEUR CORRESPONDANT OBTENU AU MOYEN DE CE KIT

Abstract: **(EN)**The invention concerns a kit for transforming a conventional motor vehicle comprising two driving wheels, alternating internal combustion motor (ICE), into a hybrid electric vehicle, characterised in that it comprises: - two motorized wheels, provided with an electric motor (EM) an a braking system, - a control unit (VMU) for said two motorized wheels; - a solar panel, even of the auto - steerable type during only the parking phases, to increase the energetic advantages of the hybridization by exploiting the solar energy both during the drive and in the vehicle stop phases; - a supply battery (Battery) of the electric motors (EM) of said motorized wheels.

(FR)L'invention concerne un kit pour transformer un véhicule à moteur classique, comprenant deux roues motrices et un moteur alternatif à combustion interne (ICE), en véhicule hybride solaire, caractérisé en ce qu'il comprend : deux roues motorisées pourvues d'un moteur électrique (EM) et d'un système de freinage; une unité de contrôle (VMU) pour ces deux roues motorisées; un panneau solaire, du type à orientation automatique durant les phases de stationnement uniquement, pour augmenter les avantages énergétiques de l'hybridation par une exploitation de l'énergie solaire à la fois pendant les phases de conduite et les phases d'arrêt du véhicule; une batterie d'alimentation (batterie) des moteurs électriques (EM) des roues motorisées.

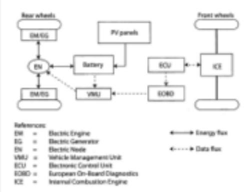


Fig. 1

Designated States: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.
African Regional Intellectual Property Organization (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW)
Eurasian Patent Organization (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM)
European Patent Office (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR)
African Intellectual Property Organization (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Publication Language: English (EN)
Filing Language: Italian (IT)

Exhibit [12]: Horizon 2020 SME Instrument – Phase 1

Please, find the complete version of the list of beneficiaries here.

Horizon 2020 SME Instrument Updated in March 2015 Phase 1 beneficiaries

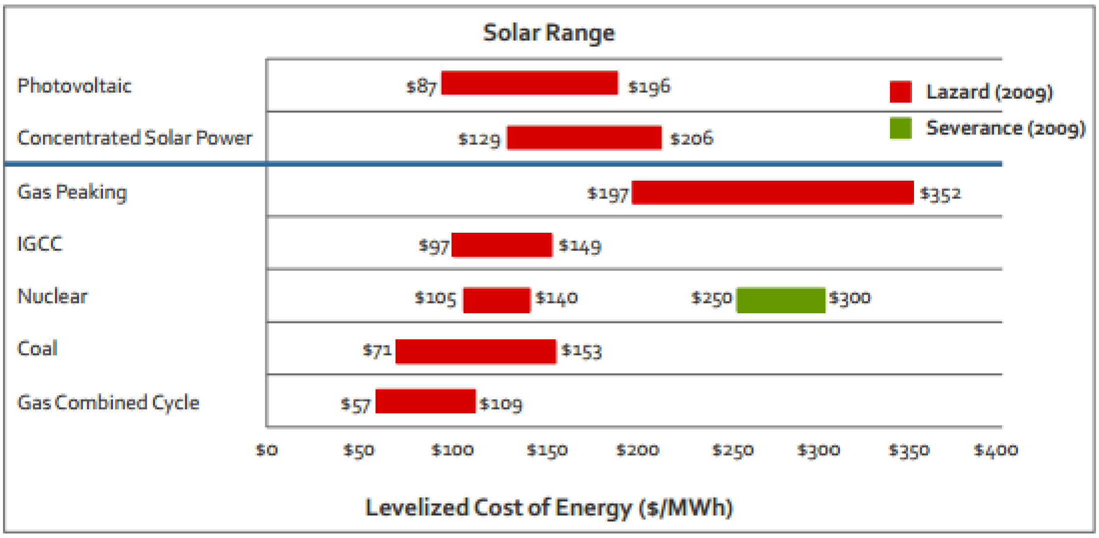
Country	City	Beneficiary	Website	Proposal Acronym	Long name	Call Deadline Date	Topic
Italy	Costa di Mezzate	GUALINI SPA		FIBGLOW	High insulating fiberglass window and curtain wall profiles	17/12/2014	Stimulating the innovation potential of SMEs for a low carbon energy system
Italy	Roncadelle (Brescia)	Xeos.it		HELMO	Cardiovascular Diseases Diagnoses by means of Smart Remote Monitoring System based on known Heart Activity Biomarkers	17/12/2014	Clinical research for the validation of biomarkers and/or diagnostic medical devices
Italy	Busto Arsizio	Air Bonaita		HYPAS	Next Generation Energy Efficient, Inexpensive Hydropneumatic Hybrid Actuation System	17/12/2014	Stimulating the innovation potential of SMEs for a low carbon energy system
Italy	Fisciano (SA)	eProInn		HySolarKit	Converting conventional cars into hybrid and solar vehicles	17/12/2014	Small business innovation research for Transport
Italy	Firenze	pnat		JFB	Jellyfish Barge - A floating greenhouse	17/12/2014	Resource-efficient eco-innovative food production and processing
Italy	Vimodrone	Bios s.r.l. s.u.		LOUISA-3D	Clinical validation of Laser Optoacoustic Ultrasonic 3D Imaging System Assembly for breast cancer detection and characterization through endogenous biomarkers.	17/12/2014	Clinical research for the validation of biomarkers and/or diagnostic medical devices
Italy	Milano	Value Bio Tech S.R.L.		MILANO ROBOT	Minimal Invasive Light Automatic Natural Orifice Robotic Platform	17/12/2014	Open Disruptive Innovation Scheme (implemented through the SME instrument)
Italy	Ferrara	Caleidos		MgSpa	A highly efficient and eco-friendly electric shower offering health benefits through magnesium sulphate	17/12/2014	Boosting the potential of small businesses for eco-innovation and a sustainable supply of raw materials
Italy	Monza	comftech		NewMoon	NewMoon - Smart Garments in Newborns and Babies Monitoring	17/12/2014	Clinical research for the validation of biomarkers and/or diagnostic medical devices
Italy	PORTE	GRINP		PAIR	Plasma active pollution control system	17/12/2014	Boosting the potential of small businesses for eco-innovation and a sustainable supply of raw materials
Italy	Zola Pedrosa	ANDERLINI		PreNANOCOAT	Metal powder coating system with nano-technology pre-treatment.	17/12/2014	Accelerating the uptake of nanotechnologies, advanced materials or advanced manufacturing and processing technologies by SMEs

Exhibit [13]: Solar Energy Industry segmentation matrix.

		TECHNOLOGY	
		Photovoltaic (PV)	Solar Thermal (ST)
APPLICATION	Distributed	PV - On the roof [*]	Solar Heating & Cooling (SHC)
	Central/ Utility	PV - Utility [*]	Concentrating Solar Power (CSP) [*]

[*] = 'Generates electricity'

Exhibit [14]: Cost comparison between solar energy and traditional generation technologies.



Source: SEIA 2009 Supplemental Charts

Exhibit [15]: Composition of a solar module.

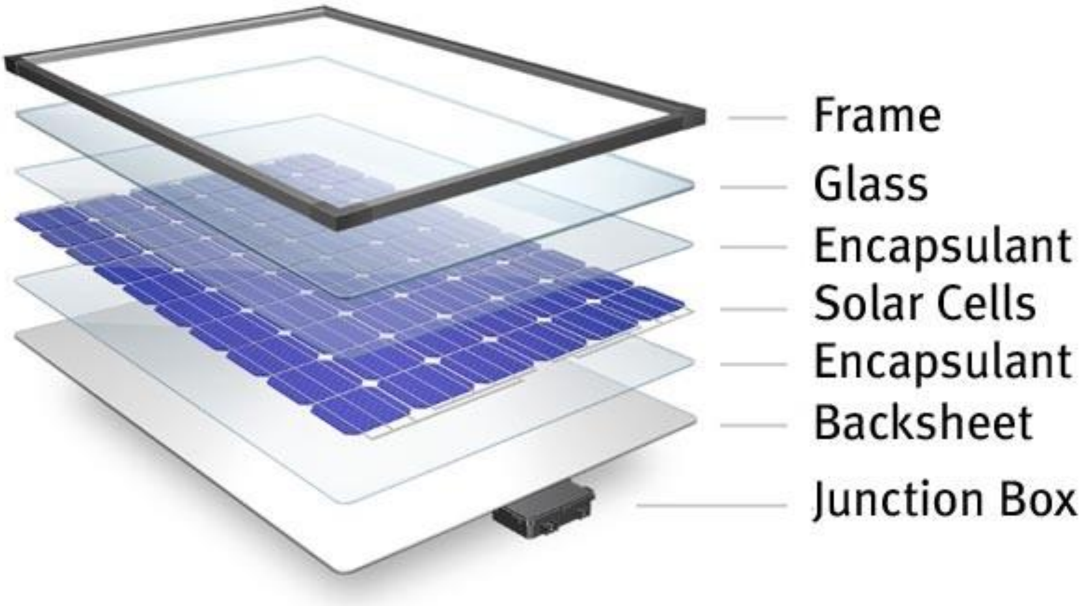


Exhibit [16]: Solar panel families.

- **Monocrystalline** (or Single Crystal) is the original PV technology invented in 1955, and never known to wear out. Single crystal modules are composed of cells cut from a piece of continuous crystal. The material forms a cylinder which is sliced into thin circular wafers. To minimize waste, the cells may be fully round or they may be trimmed into other shapes, retaining more or less of the original circle. Because each cell is cut from a single crystal, it has a uniform colour which is dark blue.
- **Polycrystalline** entered the market in 1981 and it is similar to monocrystalline in performance and reliability. They are made from similar silicon material, except that - instead of being grown into a single crystal - they are melted and poured into a mold. This forms a square block that can be cut into square wafers with less waste of space or material than round single-crystal wafers. As the material cools, it crystallizes in an imperfect manner, forming random crystal boundaries. The efficiency of energy conversion is slightly lower than with monocrystalline. This merely means that the size of the finished module is slightly

greater per watt than most single crystal modules. The cells look different from single crystal cells. The surface has a jumbled look with many variations of blue colour.

- **Thin film (amorphous)**: a PV cell made with a microscopically thin deposit of silicon, instead of a thick wafer, that uses very little of the precious material. It is deposited on a sheet of metal or glass, without the wasteful work of slicing wafers with a saw; the individual cells are then deposited next to each other, instead of being mechanically assembled. This is the idea behind thin film technology. The active material may be silicon, or it may be a more exotic material such as cadmium telluride. Thin Film Technologies film panels can be made flexible and light weight by using plastic glazing. Some flexible panels can tolerate a bullet hole without failing. Some of them perform slightly better than crystalline modules under low light conditions. They are also less susceptible to power loss from partial shading of a module. The disadvantages of thin film technology are lower efficiency and uncertain durability. Lower efficiency means that more space and mounting hardware is required to produce the same power output. Thin film materials tend to be less stable than crystalline, causing degradation over time.

Exhibit [17]: Vehicle demand management around the World (Embarq, 2013).

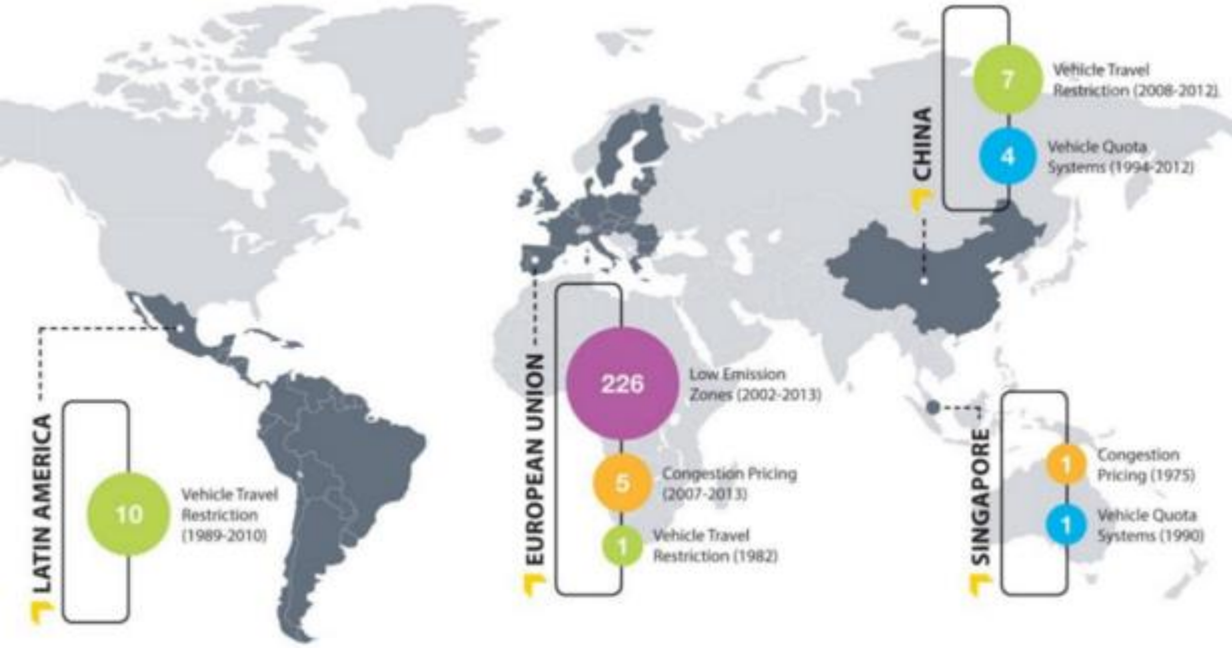


Exhibit [18]: Evolution of the main sustainable mobility trends over time.

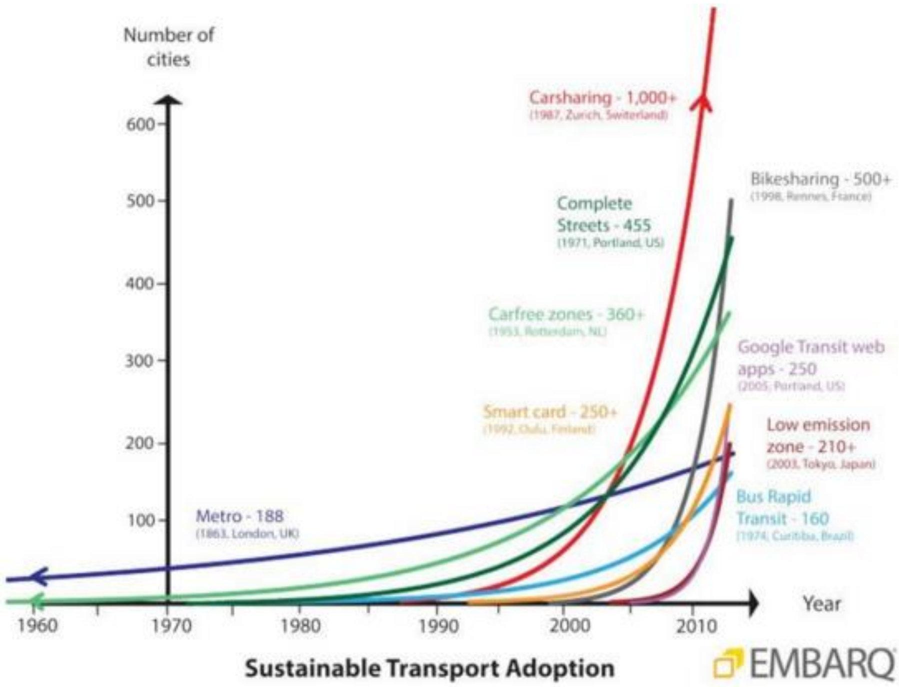
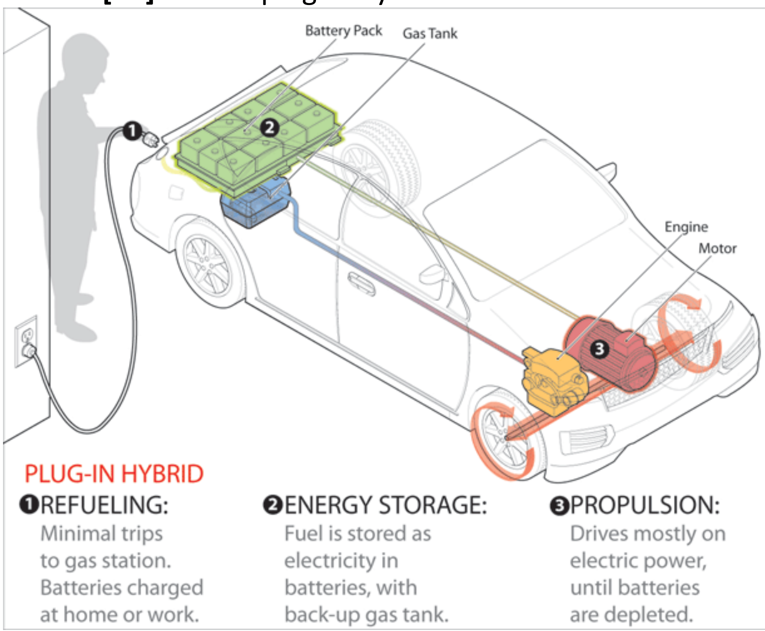


Exhibit [19]: How a plug-in hybrid vehicle works.



TEACHING NOTE

Case Overview

This case study is about the implementation of a university research project, HySolarKit. HySolarKit was developed at University of Salerno in order to provide a solution to convert gasoline-fuelled vehicles into hybrid ones. Salerno and its suburbs are characterized by low population density – compared to other areas of Campania region - and low number of start-ups, which highlights a lack of propensity to innovate. The product belongs to a segment that links the fields of sustainable mobility, hybrid cars and solar panels. Each of these sectors provides additional complexity to the implementation process of HySolarKit.

The project has gained international attention and praise, thanks to the effort of its founder, Gianfranco Rizzo, and the spin-off company working on its development, eProInn; however, HySolarKit has been in the prototype phase for almost 10 years now. The main challenges, now, concern commercialization and scaling up. If Gianfranco Rizzo and eProInn do not manage to properly address them, HySolarKit will likely become just one of the several projects that, after being developed in a university lab, never reached the market.

Teaching Objectives

After discussing this case, students should be able to:

- Analyze the complexity of commercialization phase.
- Analyze the complexity of the scaling up decisions.
- Weigh the benefits and risks of incorporating the environmental dimensions into decisions on business strategies.
- Understand the peculiarities of the development of a new product within the Italian academic environment.

Case Pedagogy

This case is intended for undergraduate and graduate students who are enrolled or interested in business strategy, energy development, public and environmental health, managing new ventures, organization, economics of corporate sustainability, managing public-private partnerships.

Teaching Plan

Class Introduction - Priming Questions for the Instructor

- Which are the main challenges, when bringing a university project to the market?
- Which are the most common mistakes during the scaling up phase of a product?
- How important is it to balance profitability and environmental sustainability in the implementation of a new product?
- Does a public institution face additional challenges in developing a product for the private market?

Major Topics for Case Discussion

Who could be the final users of HySolarKit? How to best capture their attention?

Over the years, the team had always seen individual drivers as potential targets for HySolarKit, but a more precise identikit of the target customer is necessary. He/she surely has to be a usual driver, and preferably within an urban context, where the performance of the car is a less valuable attribute, with respect to other features such as environmental impact, fuel consumption, ease of parking. Moreover, the targeted user needs to be a so-called *opinion leader*, someone who could further ensure adoption by other buyers at a later stage (as defined by Rogers in 1962 - *See Exhibit [1] for a complete classification of technology adopters).* Finally, the addressed group has to be big enough to be able to sustain the product in the long run. Thus, several categories can be targeted for the implementation. Some ideas: taxi drivers and wealthy family moms.

Marketing implies figuring out how to involve customers beyond the early adopters. Initially, it could happen through industry associations and through a promotion effort, to be coordinated with the distributor. In a later stage, eProInn could consider a larger-scale advertising action, exploiting more traditional channels, such as online and TV ads. Whatever the strategy will be, it is crucial to improve the quality of both the website and the periodical newsletter.

Does Salerno offer sufficient potential for the product launch?

Advantages of launching in Salerno and suburbs: HySolarKit was born there, strong connections, deep knowledge of the local way of doing business.
Disadvantages: 1 million people population including the suburbs, limited propensity to innovate among the local population.
Gianfranco Rizzo could exploit his international relationships to tap further markets: Campania region, at least in the first implementation phase, could represent a good test; later on, other national and foreign opportunities could be pursued.

How would you exploit the existing network of Gianfranco Rizzo and eProInn? Could it be useful to involve public partners? In which direction would you expand the network?

The network built by Gianfranco Rizzo through the promotion of HySolarKit over the years provides a set of advantages: technical partners can be useful in the industrialization phase – at least at a small scale level; media channels – already exploited – can be further leveraged in the promotion activity; foreign partners can represent sources of funding and useful connections to enter new markets in the future.

Cooperating with public partners could help increasing the awareness around the product and facilitating the commercialization through the introduction of subsidies linked to the purchase of the kit. It has to be taken into account that the Italian bureaucracy considerably slows down every process: therefore, this option could support a long term strategy, but cannot be exploited in the short term.

It is also fundamental to strengthen the links with car makers, in order to build a stronger base for scaling up.

Which distribution channel could be the most suitable for HySolarKit?

The weak links with the main players in the automotive industry prevent HySolarKit from being installed before the car is sold to the final customer. Hence, the distribution channel that could be currently exploited is represented by the garages that already install other kits (e.g.: kits for methane or LPG) and that are largely present and used in Italy.

Should eProInn develop another version of HySolarKit before starting to commercialize it?

The long development times that have characterized the previous prototypes suggest that it is better develop a refined version only after the product has been introduced on the market. It would allow HySolarKit to take advantage of the increasing awareness around car-generated pollution, further raised by scandals involving big players in the automotive sector.

Can the product operate at scale? If so, will the company as now be able to support the scaling up?

In order to implement large scale production, eProInn needs to figure out if and how to build a solid infrastructure of systems and a coordinated supply chain that could bear a higher amount of units produced. Two possible paths can be: stay nimble and flexible, serving a niche segment with high willingness to pay, or scale up and target a broader market. Considering that the automotive industry is commercializing an increasing number of hybrid vehicles at competitive prices, the second path seems tougher to be followed. In both cases, the culture and the size of the partners has to be taken into account, in order to successfully implement the scaling process.

Scaling naturally implies to significantly grow the number of employees in the organization; therefore, the company has to ensure it has competent management and organizational routines that will drive it forward. Recruiting is key here and it is where start-ups have proved most likely to struggle: culture likely changes as more layers of management are added, and some of the original members may not agree with the new setup.

In order to keep track of all the steps and individuals involved in this phase, and to monitor the company's performance as a whole, accurate forecasting and KPI's are crucial tools.
Some useful indicators could be: growth rate of kits sold, number of defective products as a percentage of total products and number of points of sale involved in the distribution process.

Points to Highlight

In order to assess the optimal balance between economic and environmental sustainability, some frameworks from the academic literature can be helpful (i.e. canvas business model, business cases of sustainability – *See Additional Readings for the Instructor*).

The public nature of the institution in which the project was developed could worsen the challenges highlighted in the previous questions. Nevertheless, it is important that Gianfranco Rizzo and eProInn manage to successfully capture the advantages coming from this relationship.

Conclusion

In 2015, a crowdfunding initiative has been implemented, in order to financially support the phases of commercialization and scalability, highlighting a strong commitment to the further development of the project. However, the above mentioned challenges will require a careful and comprehensive managerial effort.

Additional Readings for the Instructor

Exhibit [A] for a complete classification of technology adopters

Exhibit [B] for data about Campania main cities and population

Exhibit [C] for some the main challenges of the commercialization phase

ADDITIONAL READINGS FOR THE INSTRUCTOR

Exhibit [A]: Adopter categories (E.M. Rogers, 1962).

When talking about the diffusion of an innovation, five adopter categories can be identified, and while the majority of the general population tends to fall in the middle categories, it is still necessary to understand the characteristics of the target population. When promoting an innovation, there are different strategies used to appeal to the different adopter categories.

1. *Innovators* - These are people who want to be the first to try the innovation. They are venturesome and interested in new ideas. These people are very willing to take risks, and are often the first to develop new ideas.
   Very little, if anything, needs to be done to appeal to this population.
2. *Early Adopters* - These are people who represent opinion leaders. They enjoy leadership roles, and embrace change opportunities. They are already aware of the need to change and so are very comfortable adopting new ideas.
   Strategies to appeal to this population include how-to manuals and information sheets on implementation. They do not need information to convince them to change.
3. *Early Majority* - These people are rarely leaders, but they do adopt new ideas before the average person. That said, they typically need to see evidence that the innovation works before they are willing to adopt it.
   Strategies to appeal to this population include success stories and evidence of the innovation's effectiveness.
4. *Late Majority* - These people are skeptical of change, and will only adopt an innovation after it has been tried by the majority.
   Strategies to appeal to this population include information on how many other people have tried the innovation and have adopted it successfully.
5. *Laggards* - These people are bound by tradition and very conservative. They are very skeptical of change and are the hardest group to bring on board.
   Strategies to appeal to this population include statistics, fear appeals, and pressure from people in the other adopter groups.

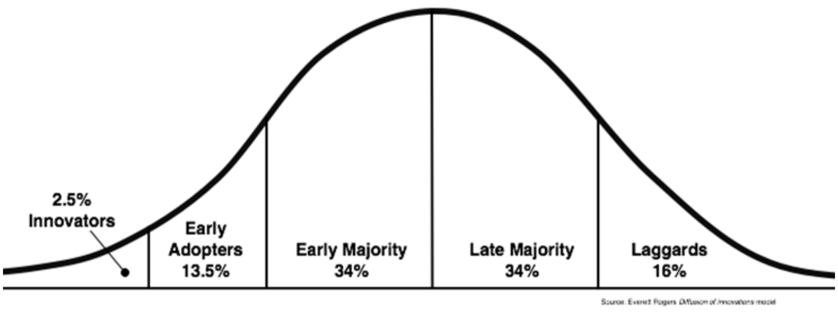


Exhibit [B]: Campania main cities and population data.

Province	Population (inhabitants)	Area (Km2)	Population Density (inhabitants/km2)
Napoli	3'118'149	1'178.93	2'645
Salerno	1'108'509	4'954.16	224
Caserta	924'614	2'651.35	349
Avellino	427'936	2'806.07	153
Benevento	282'321	2'080.44	136
			Source: ISTAT (01/01/2015)

Exhibit [C]: Some of the main commercialization challenges identified by recent literature.

Study	Challenges	Application
Pellikka et al. (2012)	Marketing, resources, business environment, and planning and management of commercialization process	General
Tahvanainen & Nikulainen (2011)	Lack of time, lack of interest, negative attitude of research environment, economic risks, conflicts of interest, bureaucratic disturbance, lack of business or commercialization knowledge, incompatibility of commercialization with the ethics of science, and ownership right problem	General
Chiesa & Frattini (2011)	Volatility, interconnectedness, and proliferation of new technologies to fit the market	General
Bulsara et al. (2010)	Patent filing processes, commercialization interest, selecting of commercialization options, commercialization supports, obsolescence of technology, educational and business background of innovator, and general business environment	General
Epting et al. (2011)	Inventor's procrastination for making a perfect product, licensing issues, insufficient funds, and insufficient time and expertise to establish distribution and supply chains	General
Rosa & Rose (2007)	Financial problems and human resource problems	General
Parker & Mainelli (2001)	Innovators' assumption, top-down market analysis, insufficient test of the technology, failure to assign specific person or team to oversee commercialization process and inability to value the new technology	General

Source: http://timreview.ca/article/864