

GREEN PROPULSION IS SMALL BEAUTIFUL?

The projected launch of a hybrid roadster in Belgium



This case was written by Michele Johnson, Fabrice Pirnay and Bernard Surlemont from the University of Liège, with support from Charlotte Butler, Research Consultant. It was made possible through the generous cooperation of Green Propulsion. The case is intended for class discussion rather than to illustrate either effective or ineffective handling of management situations. The development of the case was enabled by a grant from the European Community (ENT/EFORCE). Sole responsibility for the case resides with the authors.

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North America
t +1 781 239 5884
f +1 781 239 5885
e info.usa@thecasecentre.org

Rest of the world
t +44 (0)1234 750903
f +44 (0)1234 751125
e info@thecasecentre.org

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In January 2010 Brigitte Bardot, a freelance writer for a business magazine, was commissioned to write a special report on entrepreneurs working in the field of green technology, more specifically hybrid vehicles. The core of the assignment was to understand how small companies developed: the strategies they put in place and how they managed change. A secondary aim was to analyse how they fixed their priorities and where they found the necessary financial and human resources for growth.

While researching the industry Bardot came across Green Propulsion (GP), a small spin-off situated near Liège in the French-speaking part of Belgium. GP had just created a new company called 'Imperia' to produce a hybrid roadster. To the reporter, the interesting issue was how they were going to manage a dual-focus organisation: research, development and innovation on the one hand, and car manufacturing on the other.

The day of her visit to GP it was snowing heavily. Parked in front of the company gates and early for her appointment with the CEO, Bardot began to read through her notes on the hybrid car industry. She had already watched several videos on the subject to understand what the battery-driven cars were all about (Exhibits 1 & 2). Now as she waited in the warmth of her car she reviewed the main facts and figures on the industry and markets...

The industry

Hybrid vehicles

A hybrid car is a vehicle that uses both a traditional engine (combustion) and a rechargeable system (typically operated by a battery) in order to improve mileage, cause less pollution and reduce petrol consumption. The cleanest and most efficient energy source for these vehicles is electricity but the drawback is that the battery needs to be constantly recharged.

In 2010, the future appeared to lie in the creation of a fuel cell combining hydrogen and oxygen to create electricity, as the only exhaust produced by the cell was water. At that time, every car manufacturer was looking for ways to resolve the huge problems associated with hydrogen distribution and onboard storage. In the meantime, in response to demands for clean air and energy consumption reduction they came up with an interim solution: hybrids. The advantage of the hybrid was that to recharge the battery, drivers did not need to plug into an outlet.

The Development of the Hybrid car sector

In 2009, the automotive industry was one of the main engines of the European Union (EU) economy. The EU, then made up of 27 countries, was the world's largest vehicle producer with fifteen international carmakers producing 20 million car vehicles a year. According to the European Automobile Manufacturers Association ACEA (2010) this represented a quarter of global output. Over 12 million people were directly or indirectly employed by the industry. Annually, European governments earned over €380 billion from vehicle taxes. The industry was also the biggest investor in R&D (4%) which was above the European required 3% limit, and the major dynamo for innovation within the European Union.

The major car manufacturers in the hybrid sector were: Toyota (Prius), Lexus, Volkswagen, Volvo, Honda, Porsche, Ford, GM and the Chevy Volt (also known as Opel Ampera) together with smaller companies such as Quantum Technologies, Fisker Automotive and Aptera Motors, these three all based in California USA. Fisker had produced the first ever hybrid car, the Karma, a hybrid luxury model. The prices of these vehicles varied as the Consumer Guide Automotive and hybrid cars websites demonstrated.¹

¹ <http://www.hybridcars.com/pricepulse/> (accessed 14th September 2010)
Consumer Guide Automotive : <http://consumerguideauto.howstuffworks.com/the-consumer-guide-to-hybrid-vehicles-cga.htm>

Lithium Batteries ²

By 2010, the leading car manufacturers were battling to see who could produce the first lithium-ion battery. In the past, the US had been the market leader in memory chips, digital displays, the first solar panels and the original lithium-ion batteries used in notebook PCs and cell phones. However, at the beginning of the 21st century the global landscape changed, with Asia emerging as a serious contender in the electric car battery war. In 2009, President Barack Obama set a target of having one million electric cars on U.S. roads by 2012. Most industry experts agreed that lithium ion, which can be used to create batteries that weigh far less and store more power than those in the current hybrids, would be the dominant technology.

However, Menahem Anderman, President of Total Battery Consulting in Oregon House, California, had serious doubts as to whether there would be a mass market for electric cars within a decade. In 2009, petrol cost US\$4 a gallon and consumers who shelled out the extra US\$3,000 for a hybrid car like the Prius, with nickel-metal hydride batteries, were close to breaking even. But once all the electronics were included, next-generation lithium-ion batteries would add at least US\$8,000 to the price of a plug-in. For drivers to save money on the (Chevy) Volt, Anderman calculated, production would have to reach 1 million cars a year by which time the price of petrol, it was estimated, would have reached US\$5 a gallon.

Enter China

In the first decade of the 21st century, the electric car industry was in its infancy and had no entrenched competitors. Then in 2010, the Chinese government published a five-year plan aimed at making China one of the leading producers of hybrid and all-electric vehicles by 2015. Although Japanese car makers such as Toyota and Honda were leading the field at that time, Chinese car producers such as BYD, Chery Automobile Co and Geely (which had acquired Volvo) quickly became serious contenders.

The industry was given a huge boost by the Chinese government, which encouraged 13

² http://www.businessweek.com/magazine/content/09_08/b4120052113533.htm : « The electric car battery war », BusinessWeek (Feb 12th, 2009) by Pete Engardio

major cities to adopt green transport policies. Subsidies of up to US\$ 8,800 were offered to taxi fleets and local government agencies for every hybrid or all-electric vehicle purchased. The state electricity grid was ordered to set up electric car-charging stations in Beijing, Shanghai and Tianjin. The Chinese government also decided to follow European, US and Japanese governments by introducing tax breaks and other subsidies so that Chinese technology could compete with that of General Motors Co, Chevrolet Volt and Tesla Motors Inc's Roadster.

One of China's main challenges was to combat air pollution due to its rapid industrialization.³ This, together with the government's desire to cut the country's dependency on imported oil, increased the pressure to produce 'green' vehicles and made the Chinese market potentially the most attractive in the world for hybrid car manufacturers.

European Union legislation⁴

On March 10th 2010, the European Commission adopted the first international regulation on safety for both fully electric and hybrid cars at the United Nations in Geneva. Electric vehicles operated at high voltages of around 500 volts, so safety would be paramount for future buyers. In the next ten years, conventional cars would still be the dominant power-train but by 2030, the global car fleet was expected to grow from 800,000 million to 1.6 billion, and to 2.5 billion by 2050.

By that time too, energy resources would be even scarcer and the cost of energy supplies even higher. Given this scenario, ultra low-carbon electric power-trains and hydrogen fuel cells were seen as the most promising options. France, Spain, Germany, Portugal and Denmark all began to promote electro-mobility.

³ http://www.nytimes.com/2009/04/02/business/global/02electric.html?_r=1&ref=keith_bradsheer : « China Vies to Be World's Leader in Electric Cars » By KEITH BRADSHER, Published: April 1, 2009 (New York Times) accesses 7/9/2010

⁴ http://ec.europa.eu/research/transport/info/article_9087_en.html "A Key Driver of the European Economy"

Green Propulsion

The day before meeting Green Propulsion's CEO, Bardot visited Interface, the technological transfer service of the University of Liège, to dig into the story behind GP's creation.

A multidisciplinary, multilingual company concerned with the economic development of Belgium's Walloon region, the main mission of Interface was to encourage collaboration between industry and the university by promoting start-ups and funding spin-offs. Luc Etienne, a director at Interface, had followed GP's progress from its creation to the setting up of the new company, Imperia, and proved an eager source of information about the company's founders and current activities.

The GP founders

"Green Propulsion", explained Etienne, "was set up by three graduates who met in the 1990s at Liege University. Yves Toussaint, GP's CEO, was an electro-mechanical engineering graduate with a doctorate in Applied Sciences. In 1992, he travelled to Brazil, Ethiopia and the former Belgian Congo to carry out voluntary work and on his return, became a researcher in the University's Mechanics and Transport department, where engines and vehicles were laboratory-tested.

GP's project manager, Nicolas Naniot, graduated as an electro-mechanic engineer in 2000 and then also became a researcher in the Mechanics and Transport Dept. His expertise was in the energetic management of the hybrid vehicle and digital communication systems. The third founder, Bernard Loly, was a graduate in automation and responsible for the practical construction of tests and prototypes at GP. His fields of expertise were mechanics, electricity and electronics.

Luc Etienne described how he helped the three set up GP in December 2001 as a co-operative limited company (which was the cheapest option) because they were convinced that hybrid motorisation would be the future for the car manufacturing industry. As he told Bardot; "they were continually looking to integrate new technologies and were at the cutting-edge of best practices in their field".

The company was initially capitalised at €44,000, with each founder investing 24% and the university the remaining 28%. Thus, with their 72% investment the three friends controlled decision-making. If the university had continued to support their research, believed Etienne, they would probably not have set up a company; it was circumstances and a passion for their research that pushed them into forming a spin-off.

GP's Activities

GP provided expertise in the fields of cleaner motorisation and sustainable mobility. Their main customers were government offices and public sector institutions. In the private sector, their customers were mainly fleet managers.

▪ Test benches

In order to carry out its innovative projects successfully, GP had to meet specific bench test requirements which the market could not then satisfy. Accordingly, the company set up a dedicated department to develop a complete range of high-performance testing resources.

GP's dual experience with alternative motorisation and test benches was unique, and especially sought after by both the academic and professional sectors. It offered educational test benches and teaching modules for new technologies including:

- **Electric motors:** exploration of the characteristics of AC and DC motors suitable for automobile traction
- **Batteries:** exploration of the characteristics of Li-ion and Li-Po batteries suitable for automobile traction
- **Hybrid motorisations:** introduction to serial, parallel and combined management strategies for hybrid vehicles

▪ Prototypes for third parties:

The implicit knowledge acquired by the three founders through their research gave them a competitive edge over large R&D departments in multinational car manufacturing companies. As Luc Etienne explained, GP's main customers were multinational auto

corporations for whom it designed and produced specific tailor-made batteries. The projects could take months, but GP had the expertise and the flexibility to adapt its technical know-how to fit the client's particular needs.

One of the main issues in dealing with these multinational corporations (mncs) was that since GP dealt with different people on the same project, a lot of time was wasted re-explaining points that had already been covered. As employees were promoted or moved to other project, again they had to start all over again with someone new. When Bardot asked why GP had not opted to work with a single manufacturer, Etienne told her that, “The founders always wanted to keep their independence. They considered this essential as then they could work on projects that interested them, rather than those imposed by a customer”.

▪ GP's own Prototype

In 2008, GP developed its own hybrid motorisation system, patented under the name of “PowerHybrid”⁵. This technology was implemented in its Imperia GP hybrid roadster, which combined 0 to 100 km/h in 4.8s, 87 g/km of CO₂, and a 70 km range (with no direct pollution) in pure electric mode. To achieve these results, the company drastically downsized the engine using lithium-polymer batteries. Among the projects carried out by GP working on its own account were an electric motorbike, an electric and hybrid Microbus, a hybrid Renault Kangoo van and a hybrid city bus.

Meeting GP

During the interview, Luc Etienne had given Bardot three financial statements for GP. Sitting in her car outside GP the next day, having finished reviewing her notes on the industry, she looked at them to try and assess the company's financial state (Exhibit 3). Her reading was interrupted by a knock on the car window and when she rolled it down, she was told by a guy sporting an earring in his left ear to come in from the cold. Thinking he was one of the workers, Bardot told him she was there to meet the CEO. The guy with the earring replied “that's me!” Yves Toussaint had just arrived in a small Fiat. Once they were inside, he offered to take Bardot round GP's offices and workshops.

⁵ <http://www.imperia-auto.be/en/powerhybrid.php>

During the tour, she began to interview Toussaint about himself and how the company operated.



Asked how he defined his role as an entrepreneur and CEO of GP, Toussaint told her that he was “...not born into a family of entrepreneurs so I had no role model to follow, nor any reference. When we set up GP, if someone had said that one day we would be 13 collaborators I would have told them I was incapable of managing so many people. But now I find it doable”.

Experience and know-how accumulated in this cutting-edge sector had, he explained, encouraged the three founders to develop their own projects: “Either the client comes with a detailed plan and asks us to do a project (prototype) corresponding to the specifications stipulated in the plan (for example a car manufacturer asks us to design an electric car with an autonomy of 120 km maximum) or someone asks us to solve a problem and leaves us to find an optimal technical solution. For example, a transport company asked us to find a new motorisation system for their bus in order to reduce the ecological impact without altering its autonomy. We were free to adapt one of their buses and try to find a solution. These kinds of projects have enormous added intellectual value. They need complementary and integrated competences in several advanced fields (simulation, dimensioning, mechanical, electronic, IT and welding skills”.

Growth strategy

GP's growth strategy was a subject that had aroused Bardot's curiosity. She had quickly realized from her earlier research that in fact, GP had no clear strategy for growth. Rather, it 'emerged', as did the need for to expand the work force. As the work became more complex and time-consuming, the company recruited someone for a specific task. For example, because time was being wasted searching on-line for equipment, raw materials and spare-parts' suppliers, an IT expert was recruited to deal with all the orders, supplies and to update the company website. GP also hired a mechanic, Olivier, who had previously worked on sports cars and had the ability to assemble spare-parts and deal with any structural problems. The company frequently accepted unpaid interns who worked on a project for GP. If the intern fitted in with the organisational culture, then the intern was offered a position with GP when he/she left university. However, if someone had the right skills but did not fit in with the organisational culture, they would not be kept on; "Interns are our main source of recruitment: out of 13 staff members 8 were recruited after an internship" commented Toussaint.

The Organisation

As Toussaint proudly told Bardot, there was no organisation chart for GP. He liked a flat organisation and did not believe in performance appraisal reviews. He considered them a waste of time and believed they could have a negative impact on the organisational climate. Relationships in GP, he maintained, were based on trust. He gave the example of a time when the company had a cash flow problem and could not pay salaries. GP's employees, he recalled, had accepted a delay in receiving their pay because the company philosophy was not oriented towards financial rewards.

The workforce consisted of the three founders, four interns, three mechanics, an electrician, an IT expert and a sales and marketing manager. Every Monday they got together to discuss new projects and on-going work so that everybody knew what they would be doing that week. Every technical aspect was discussed in detail and every Friday afternoon, there was an informal get-together.

Several times during Bardot's tour, different employees told her about these Friday afternoons. Luc Etienne had said he would not miss them for the world. Gilles, a former intern and in January 2010 the sales and marketing manager hired for Imperia, described them to her.

“At the end of each week we have an aperitif with a few crisps, a bottle of wine or a crate of beer. It's a tradition firmly rooted in our organisational culture and a very important moment, because it's one of those rare times when we are all together in the same place and can talk freely to one another about anything under the sun. However, I have to say that most of the time our conversations are about work-related issues - how projects are doing, contacts with a supplier.... - and it's during this get-together that we exchange ideas, make suggestions, offer solutions, launch new ideas without the fear of being judged.....It's a relaxing, friendly time together before the weekend starts”.



Looking at the photo Gilles produced, it was clear to Bardot that the company's values and beliefs were firmly rooted in the day-to-day running of the company, and were the glue that held Green Propulsion together.

The survival instinct

As Toussaint explained to Bardot, a small company had to learn to survive. To portray this instinct acquired over the years he described something that happened in 2006. Then,

GP had fitted a bus with an electric battery and the bus had subsequently caught fire. The first reaction had been to blame Green Propulsion and as he recalled: “When you are confronted with such a situation, you don’t understand what is happening and you ask yourself how did it happen? Are we responsible? How will the partners with whom we are currently working react? Will we lose their trust - will they blame us and question our competence in the prototype projects? How are we going to pay salaries if some of our clients refuse to work with us because of this incident?”

Yet despite the stress of this setback, Toussaint had refused to give way and had managed to maintain the trust of his clients and other stakeholders. Support from Luc Etienne, and a retired Professor who had supervised the three founders as graduates and given them unfailing support and advice, had helped pull the team through this difficult period. In the event, the clients had not lost faith in GP’s capabilities and the three had gained a new competence; a ‘survival instinct’.

In fact, Bardot already knew about this episode since the day before, Luc Etienne had described in detail how GP had survived; “A lot was down to the flexibility of the founders, two of whom went to work temporarily outside GP, without pay, to reduce the company’s fixed costs. Yves’ tenacity led him to stay in the company where he juggled multiple consultancy contracts to bring in the money to assure GP’s future. Thanks to the trust shown by GP’s main partners (above all the company whose bus had burned down) the company overcame this difficult period and emerged from the disaster much stronger than before.”

GP was finally cleared of any responsibility for the incident. The fire had started at the front of the bus, and the firm’s battery had been installed at the back. However, a small company like GP could easily have had its image tarnished by the affair and been forced to exit the industry.

Toussaint’s stamp on the company was also evident in its ethical approach. “Following the bus incident”, he told Bardot, “even when we were really down in the dumps, I would rather have quit the company than used my skills to work on certain projects, such as

anything linked with the military. I have strong feelings about ethical issues, which I have tried to instil in GP”.

These feelings were linked to his experience during voluntary service overseas, which had etched images of poverty and war-ridden countries onto his mind. Consequently, orders for hybrid batteries destined for army tanks or lorries were always turned down. Bernard Loly, the other founder, was equally adamant about GP’s ethical approach, “We have refused to work on projects aimed at developing combustible batteries because we are convinced they are not a solution for the future. We will only work on projects and technologies we believe have a future and to us, green technology is that future”.

The Imperia project

The three founders had always had a passion for cars, and one of their dreams was to one day design and manufacture an environmentally-friendly sports car. In 2009, the idea became reality when they designed their own sports vehicle. Commercialised under the brand name IMPERIA, the roadster would be equipped with a PowerHybrid engine.

The Imperia roadster was a vehicle whose consumption and CO2 emissions were comparable to those of a Smart car, whilst still guaranteeing an outstanding performance that easily rivalled established marques like Ferrari or Porsche.

IMPERIA had once been a well-known Belgian carmaker located in Nessonvaux (Wallonia) which had closed down in the 1950s. By resuscitating the brand, the three founders sought to use nostalgia to appeal to a specific market segment. For Belgian clients, who benefited from an environmental subsidy of € 4,540, the base price was € 89,850 incl. VAT. The idea was to keep the interior of the car very basic. However, the idea met with considerable scepticism from investors, for whom the idea of a roadster that combined a streamlined, upmarket design with a basic interior was not perhaps the best marketing sales pitch.

The marketing of the car was to be carried out on-line, backed by advertisements in

specialist magazines. Forecast sales were for 300+ models. It was estimated that two cars could be assembled per week in the production plant and that the first year would see total sales of 100 vehicles, and double that in the second year of production. The breakeven point would be met after the first year.

Assembly would be carried out in a new production plant, due to be built in 2010 in Liège. GP planned to hire unskilled workers for this, and estimated that the learning curve would allow them to produce twice the number of cars in the second year.

Interested in seeing the production plant, Bardot was startled to be shown a plot of land. The plant had not yet been built as the company was waiting for subsidies and loans. Orders were coming in but since there was nowhere to assemble the cars, nothing could go ahead. 'One day at a time' seemed to be the philosophy.

As Toussaint admitted, the sales and marketing manager had been having difficulty finding investors. Business angels and private investors wanted to see the finished product, and be convinced there would be a return on their investment before financing the project. Although at the moment the car could be seen in 3D - that was all they could see (Exhibit 4). Bardot never did find out who these potential investors were although as she was firmly told, whoever they turned out to be, the GP founders would remain in control of decision-making and would not countenance any investor holding a larger stake in Imperia than they did themselves. Bardot decided she would return to the site in June 2010, by which time the foundations should have been laid.

At that moment, Toussaint was called away giving Bardot time to reflect on everything she had been told so far. The interview was not really going as she had expected - so many questions remained unanswered while GP's business model was quite unlike that usually adopted by small start-ups. On the one hand GP's finances were quite healthy; the company was growing and planning a new production plant. But what about trying to maximise profits? Could such a small company allow itself the luxury of vetting suppliers on ethical grounds and still survive? And then there was the product; a car that was both ecological but also a sports car ... ? Her train of thought was interrupted by the

arrival of the other two founders, Nicolas Naniot and Bernard Joly.

They confirmed that they lived day-to-day working on projects. Toussaint was the 'ideas' person and played an important role in finding new projects and coming up with new technologies. They believed he was best able to meet clients and negotiate contracts. Bardot asked them about an issue that was clearly problematic; how would he and they manage two companies, GP and Imperia, which had completely different objectives. Luc Etienne had mentioned that Interface and other investors would only invest in Imperia if Toussaint was CEO of both firms.

Naniot and Loly confirmed that as far as they were concerned, Toussaint was the only person who could manage both companies. As they pointed out to Bardot, he was also the only founder working full-time at Green Propulsion. Loly worked for his family business whilst Naniot was still employed by the university, subcontracting work from Green Propulsion. Clearly, they were all passionate about cars and shared the same culture. Several times they had mentioned 'well-being' and described how they 'came to work every day because work was fun and enjoyable.' So far everyone had always been happy to plough any profits back into GP. However, although at the moment none of them seemed profit-oriented but more concerned with maintaining the prevailing organisational culture, at some point they would inevitably expect a return on their initial investment. And what, wondered Bardot, would happen then?

Future Challenges

It had taken Green Propulsion two years until 2010 to obtain the funds to continue their project of producing an ecological sports car. As Gilles pointed out: "A lot of time could have been saved if I had had the necessary background information beforehand. Projects are delayed because there is not enough money to invest in land, equipment, labour and assembling a prototype. It is frustrating".

He was interrupted by Toussaint who told Bardot, "In the UK there are over 191 small companies assembling cars for market niches. When your car is meeting the needs of a certain segment, there is nothing wrong with producing a small number of units. We

intend to assemble 200 units per year and that will be our maximum output. We are getting orders from both domestic and neighbouring markets such as the Netherlands, France etc..... Nothing will stop us from being more international in the future.....we are targeting people who are interested in owning a beautiful car and respecting the environment at the same time. In the UK, the, Morgan car company has been very successful at targeting a small market segment for the last hundred years!"

Asked about competition from the large auto manufacturers, Toussaint explained his belief that, since competition and many market players drove prices down, it was a good outcome for small businesses. Naniot had another viewpoint: "Ten years ago we were leaders in the field and had a technological advantage. However, with the growing interest in global warming and its impact, more and more industries are investing considerable amounts of money in devising an electric engine, which means it's going to become harder and harder for us to maintain our technological advance with the means we have at the moment".

As far as the future of Imperia was concerned Gilles, the Sales and Marketing manager, would have an office in the new production plant. At the beginning Toussaint would manage both companies and, depending on the number of orders that came in, would recruit a new manager to oversee the plant. Bardot noticed the look Gilles gave Toussaint when he said this. Gilles had actually been recruited for that job, but lacked any knowledge about the technologies GP was working on.

Toussaint was well-aware that a production plant would need a different management style from the one he had established at GP, but nevertheless hoped to maintain the organisational culture they had built there. The main issue would be how to maintain a balancing act between innovation in R&D at GP, and manufacturing the Imperia at the production plant.

As she drove away from GP, Bardot tried to put together everything she had learned. She knew from experience that one of the main problems for small and medium-sized enterprises was growth while another key issue was leadership. It had been obvious

during their meeting that Toussaint was a natural leader, and that any future success would be his responsibility. However, managing a bunch of researchers in an R&D centre and managing a production plant required two quite different leadership styles. Would he really prove able to manage two such different companies? There would certainly be control and quality issues in the production plant – could Toussaint deal with these? And how would Gilles fit in if a new manager was appointed - after all he had been hired to manage Imperia?

GP's unusual culture raised several important issues. Was the current organisational culture sustainable, even within GP, over the long-term? Could the present non-profit-making philosophy be maintained as the company grew - or would the partners then start pushing for higher profit margins and a return on investment? Above all, could the same values and culture, the same 'clan' mentality, be transferred from a research centre to a production plant?

Developing the Imperia, Bardot decided, posed a whole new set of issues. Could they really rely on on-line orders to forecast future sales? Was there actually a market for the new roadster? Wasn't there a contradiction between holding ecological values and producing an expensive sports car? Were any or all of these the reasons why GP was finding it so hard to find people willing to invest in the car? And if she came back next year, would the production plant be built – and GP still be a flourishing company?

Exhibit 1

Pros and Cons of Hybrid cars

<http://www.youtube.com/watch?v=XewIWTwkVhE&NR=1> October 28, 2008

Hybrid cars have extremely low emissions and high fuel efficiency, which are definite pros; however, some of the cons of hybrid vehicles include price and environmental hazards connected with the batteries.

<http://www.youtube.com/user/IHSGlobalInsight#p/u/3/fl2gRtPYxwY> (September 2009)

IHS Global Insight analysts Bruce Harrison and Phil Gott discuss the business implications of battery electric and plug-in hybrid vehicles. What is the real story for long-term viability and growth?

Exhibit 2

Types of hybrid cars (2010)

There are four different types of hybrid cars.

- a) Hybrids – battery and electric motor power cars at low speeds. The gas engine accelerates for highway driving (Toyota Prius, Ford Escape Hybrid, GMC Yukon Hybrid, Lexus LS600h, lexus 400h, Chrysler Aspen Hybrid, Dodge Durango Hybrid)
- b) Milder hybrids- the electric motor assists the gasoline engine - Honda Civic Hybrid, Chevrolet Malibu Hybrid, saturn Aura Hybrid.
- c) Plug-in Hybrids (PHEV) - full hybrids with a large rechargeable battery by plugging into an AC outlet. (at the development stage in numerous car companies)
- d) Electric car – powered by long-lasting battery and electric motor. Technology is still in the development stage in numerous car companies.

Table ES-1 Hybrid Checklist: What Kind Of Hybrid Is It?

If it ...	This vehicle is a...				
	Conventional Vehicle	Mild Hybrid	Full Hybrid	Plug-In Hybrid	Muscle Hybrid
Shuts off the engine at stop-lights and stop-and-go traffic					
Uses regenerative braking and operates above 60 volts					
Uses an electric motor to assist a conventional engine					
Can drive at times using only the electric motor					maybe
Recharges batteries using clean electricity from the wall plug and has a range of at least 20 miles on electricity alone					maybe
Sacrifices fuel economy to achieve extra acceleration performance	maybe				

http://www.hybridcenter.org/hybridcenter/images/hybrid_table3.gif

(accessed 9th

September 10)

Exhibit 3

GP financial statements

GREEN PROPULSION			
	2007	2008	2009
Intangible assets	3,304	246,729	121,702
Tangible assets	754,706	751,687	765,659
Investments	-	-	-
Fixed assets	758,010	998,416	887,361
Stock	90,720	-	377,367
Debtors	720,313	550,719	253,777
Cash at bank and in hand	29,121	34,121	64,651
Current assets	840,154	584,840	695,794
Bank loans and overdrafts	(356,178)	(131,811)	(132,012)
Trade creditors	(111,261)	(131,559)	(80,359)
Other creditors including tax and social security	(52,437)	(90,422)	(84,833)
Accruals and deferred income	-	-	-
Creditors: amounts falling due within one year	(519,876)	(353,793)	(297,203)
Net current assets	320,278	231,048	398,591
Total assets less current liabilities	1,078,288	1,229,463	1,285,952
Creditors: amounts falling due after more than one year	(557,586)	(763,757)	(752,431)
Net assets	520,702	465,706	533,520
Called up share capital	61,600	210,000	210,000
Profit and loss account	79,993	81,403	70,791
Capital and reserves	141,593	291,403	280,791
Turnover	506,944	935,726	1,630,227
Sales	420,462	465,157	901,123
Cost of sales	(248,536)	(474,711)	(812,319)
Overheads	(58,736)	(97,924)	(158,141)
Salaries & wages	(80,762)	(179,815)	(395,948)
Depreciation	(69,626)	(139,199)	(134,480)
Operating income	47,053	42,076	125,798

Source: Green Propulsion

Exhibit 4

Resurrecting Belgium's Imperia Automobiles as a Plug-in Hybrid

SYNOPSIS: The two-passenger sport coupe can operate in both hybrid and electric-only mode.

[Imperia Automobiles](#) of Liege began building automobiles in Belgium in 1900, ceasing operation fifty years later. Now it's back with a wonderfully Neo Retro, two-passenger sport coupe that blends the styling cues of its half century heritage and the state-of-the-art hybrid electric car technology.

Initially to be priced at EU85,000 (US\$127,000), the Imperia GP is a design collaboration between Denis Stevens and Green Propulsion. The chassis is fabricated out of a steel space frame with integrated safety cage. The body is rust-proof, dent resistant composite materials.

It is powered by a combination of a 2.0 liter V4 gasoline engine developing 130kW and connected to a 5-speed gear box. The electric motor provides 350 nano meters of torque at 100kW. Together they can accelerate the car in hybrid mode from 0-to-100km/h in 4.8 seconds. In pure electric mode, it's still an impressive 7.1 seconds.

The car is equipped with 31Ah of lithium polymer batteries at 266 volts. Operating in a hybrid mode, its generates 120 kg of CO₂ per kilometer. This drops to 0 in electric mode. Overall "well-to-wheel" emissions are 151 as a hybrid and 68 in pure electric.

Fuel economy is equally impressive at 5 liters/100 km operating as a hybrid. It's electric power consumption is 14 kW/h over 100 km. The driver has the option of choosing when to operate on electric power alone, with recharge taking 3 hours. The company makes no claims as to the range of the vehicle in electric-only mode, but the size of the battery pack would suggest somewhere around 100km (62 miles).

Source: [EV World](#)

<http://www.evworld.com/news.cfm?newsid=17617> (accessed 11/06/2010)

Exhibit 5

The Imperia roadster

IMPERIA GP

« The perfect marriage between electric and thermal »





The PROJECT

- Assembly and marketing of a GT roadster and its sports hybrid motorisation made by Green Propulsion
- Drastic emissions cut while keeping great driving pleasure
- Exclusive vehicle

Plug-in sports HYBRID

Imperia GP, « EcoMax » configuration

- **Electric Motor**
100 kW, 300 N.m
- **Thermal Engine**
1,6l DIESEL, 82 kW, 270 N.m
- **Batteries**
Li-Polymer, 11 kW.h, 90 kg

POWER HYBRID



PERFORMANCES

87g CO₂/km !

0 to 100 km/h in 4,8s !

> 70 km on batteries !



IMPERIA Ltd.
 Av. Pré-Ailly 20 ■ 4031 Angleur ■ Belgium
 TEL: +3242397040 ■ FAX: +3242397049
 info@greenpropulsion.be ■ www.imperia-auto.be

Source : Green Propulsion