

## Feasibility Study of BMW's Green Project



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**December 23, 2011**

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Friday December 23, 2011

Dear Professor Najjar:

We hereby submit our feasibility report concerning BMW's Green project, which mainly focuses on whether such a project can be implemented or not on an international scale. We would also like to thank you for your valuable advices that were of utmost significance and guided us through our report.

Sincerely Yours,

Mohamad Nizar Kabbani, Rajab Ghazzawi, and Diala Lababidi

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## **I. Executive Summary**

One organization that has put forth great efforts to the reduction of its own carbon footprint, and has invested great amounts of its finances into the creation of more fuel-efficient automobiles, is the BMW organization. This car manufacturer, whose name stands for Bayerische Motorenwerke, German for “Bavarian Motor Works,” has been on the leading edge of environmental protection techniques for many years, implementing new designs to make their facilities more efficient in their resource consumption. Such a step was conceived in the company’s Spartanburg facility, which has been recycling the methane obtained from the Spartanburg landfill to power the plant and to fuel production, thus effectively providing 50% of the total required energy, but also reducing the total amount of carbon released into the atmosphere by about 30%.

The BMW management has also been busy creating new designs of cars and bikes that use alternate sources of energy, which are currently revolutionizing the automobile industry. These projects targeted at introducing more efficient cars into the modern world will be presented, and their effects on the global environmental scene will be studied in detail in this report.

**Limitations:** Finally, it is worth noting that the data provided in this report is only proportional to the amount of time that was given for its preparation. Had there been more time for project development, the team would have invested further research into the mechanical aspects of these environmentally friendly automobiles proposed, designed, and manufactured by the BMW Corporation, as well as more detailed information as to their plans of their manufacturing making facilities more resource-efficient.

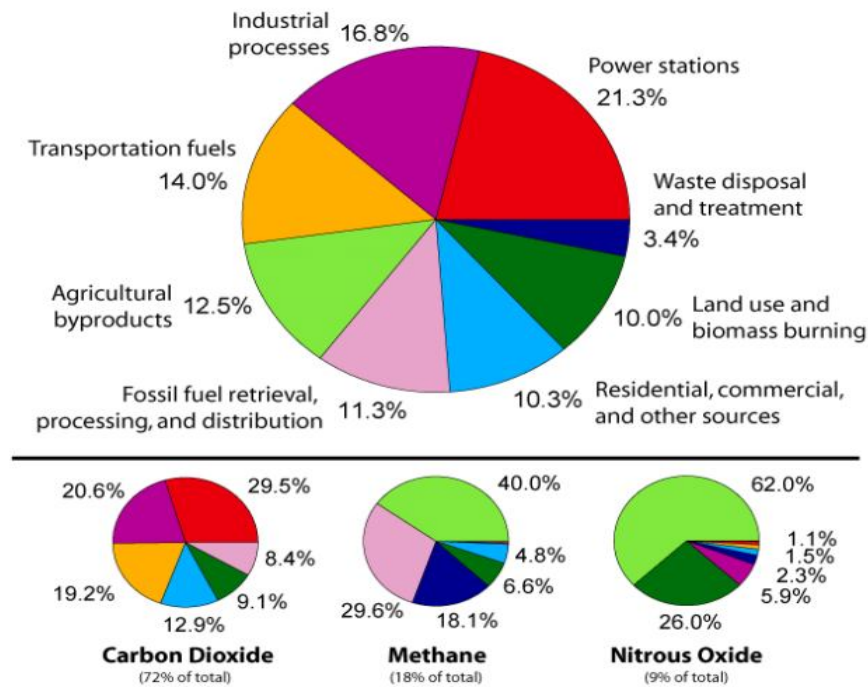
## **II. Introduction**

### **A. Background Information**

The rising levels of pollution observed worldwide, due to the boom in industrialization that has been witnessed in the 20<sup>th</sup> century, have had many adverse effects on the environment; of these are the increase in frequency of acid rain, rapid and violent weather changes, deforestation and desertification, and, most importantly, the draining of nature's resources. The cause of this rise in pollution has been our dependence on fossil fuels, namely petrol, which release chemicals referred to as "greenhouse gases" that collect in the Earth's atmosphere, causing a greenhouse effect, effectively raising the planet's core temperature. These greenhouse gases are

mostly expelled into the atmosphere by large-scale manufacturers, but there are other sources as can be seen in figure 1. A consequence of this rise is the melting of polar ice caps, followed by rising sea levels and general, drastic, changes to weather observed worldwide.

Near the end of the 20<sup>th</sup> century, research into reversing these adverse effects brought forth by industrialization was jumpstarted, with major corporations dedicating large parts of their financial resources to plans and studies centering on the reduction of the carbon footprint of these industrial organizations. The carbon footprint is defined as the total amount of emitted greenhouse gases per person/organization/product (*Carbontrust*).



**Figure 1.** Annual Greenhouse Gas Emissions by Sector

Of the organizations taking part in the worldwide endeavor to reduce the effects of industrialization on the environment, some have implemented a limit on emissions due to daily transport, by encouraging employees to carpool, that is to designate one driver everyday of several persons living within a close range of each other, to transport these persons to work and back. Other corporations have effectively limited their industrial emissions by using non-fossil fuel-based energy sources like Google, the Internet giant, which have set up one of the biggest arrays of solar panels worldwide so as to provide power to its facilities in Mountain View, California (Google Green).

## **B. Research Methodology**

For our final feasibility report that we are committed to submit on Friday December 23, 2011, we started our research by first brainstorming the main ideas that we decided to talk about and the ones we believed are the most important to our study, which is the feasibility of BMW's Green Project. After that, we surfed the Internet for online databases and sources that are relevant to our topic of choice.

However, to obtain more accurate and precise results, we decided that the analysis model should be accompanied by comments obtained through



interviewing persons involved in the fields, which will provide valuable information as to the feasibility of these green projects. In addition to that, the results of a survey conducted among students on campus concerning their views on electric automobiles will also be presented herein so as to gauge the general population's knowledge and views as to the subject matter.

### **III. BMW 2011 Green Project**

#### **A. Arguments for a Green Project**

##### **1. Environmental Benefits**

The projects proposed by the BMW automobile manufacturing corporation are notable attempts at revolutionizing means of transportation, making them more efficient, while also reducing the impact they have on the environment. Current car manufacturing procedures are responsible for a sizeable proportion (16.8%) of the total amount of environmental damage caused worldwide as they fall into the "Industrial Processes" section of the chart presented above (Figure 1). The operation of automobiles also takes part in the global production of greenhouse gases, accounting for 14% of the total

amount of such gases being expelled into the atmosphere on a yearly basis.

This total of 30.8% of the worldwide greenhouse gas emissions is equivalent to 9.3 billion tons of the global 30.2 billion tons of CO<sub>2</sub> produced and introduced into the atmosphere on a yearly basis (Tollefson, 2010). Thus, any means of reducing these monumental effects on the global environment are considered to be beneficial.

On the other hand, hybrid car model have been seeing some success in worldwide applications. These automobiles incorporate an electrical engine and an internal combustion engine in their designs, with emphasis on one or the other depending on the brand and the model. Mostly, however, it is the electrical engine driving these automobiles, while the internal combustion engine runs only when the electric charge is low, or when extra power is needed by the automobile. This traditional engine is used to recharge the battery when necessary and when an external charger is not available. In short, the amount of greenhouse gases released by this type of cars is minimal (U.S. Department of Energy, 2011).

## **2. Marketing**

In addition to being environmentally viable means, the green projects can be used as a marketing tool by these organizations actively taking supporting and applying them. Customers are generally more prone to support and purchase from a company that advertises itself as being green, while governments often provide financial support to such companies (Jackovics, 2011).

This however also has a negative aspect, as some organizations have been accused of “greenwashing,” that is the false statement that a technology is green in order to serve marketing and sales purposes. BMW was accused of such behavior in the production of its Hydrogen 7 series of automobiles (Wust, 2006).

## B. E-Design

### 1. eDrive Engine

The BMW design team has developed the eDrive model of road cars which sports an electric engine that sits directly on the rear axis thus providing the maximum amount of torque to the wheels. This model does not have a clutch or transmission and is capable of reaching 100 km/h in 9 seconds. The engine of this rear-wheel driven car produces 170 horsepower (BMW).



**Figure 2.** The BMW eDrive Model

This engine is powered by a set of lithium/ion batteries, similar to the ones used to power notebook computers that allow the car to travel up to 160 kilometers on a single charge. Charging can be done from a normal electrical socket that is available at home, while some have even set up roadside chargers, or EV chargers, (which are relatively faster) for these types of automobiles (BMW). Such EV chargers can be found in Arizona, Los Angeles, and Orange County...etc (EV Charger News, 2010).



**Figure 3.** EV charger for a BMW ActiveE.

## 2. i-Project

During the course of 2011, the BMW Corporation announced the i3 and i8 concept cars, which could be a reality around 2013 and 2014, respectively ("Bmw i3 and i8 concepts officially revealed" 2011).



**Figure 4.** From left to right, the BMW i8 and the BMW i3

The i3 is a no-emission automobile that runs on a dedicated electric engine that can run for 150 kilometers on a single charge. Its electrical motor, with a power reaching 125 kW, can drive the car up to speeds of 100 km/h (Yvkoff, 2011).

The i8 is a hybrid sports car that is proposed to be able to go from 0 to 100 km/h in less than five seconds, reaching a top speed of

250 km/h. This value is inspirational as it is not matched by any other production hybrid car available. A 3-liter petrol engine is included in the design (which caused its labeling as a hybrid) which will charge the batteries when power runs low (Yvkoff, 2011).

## **C. Hydrogen Power**

### **1. Environment**

Hydrogen-powered engines are gaining worldwide recognition for their emission being limited to liquid water. These engines are combustion engines, however as Hydrogen is the most basic element, its combustion does not produce CO<sub>2</sub>. Instead the exhaust of the automobile only releases water in vapor and liquid form. Water vapor is, of course a greenhouse gas, though its impact on the environment is considerably less than that of CO<sub>2</sub>.

## 2. Hydrogen 7 Series

The Hydrogen 7 series of automobiles is mentioned by BMW as being the first “production-ready hydrogen vehicle” (BMW). However, this model’s release has not been as wide as the statement implies. This is due to the fact that Hydrogen power is not as efficient as advertised.



**Figure 5.** The BMW Hydrogen 7





**Figure 6.** The Hydrogen 7's Engine

Though hydrogen produces considerable amounts of energy in comparison to gasoline, the monetary and energy costs of its production are greater, which severely dents the nations' ability to mass produce it.

Hydrogen is generally obtained through the electrolysis of water. This process releases two parts hydrogen and one part oxygen for every one part of water ( $H_2O$ ). The process of electrolysis requires great amounts of electrical power that is still being created using fossil fuels or nuclear power, both techniques being environmentally harmful.

## **D. Efficient Dynamics**

Reducing the company's carbon footprint is also done by making the fuel-dependent BMW automobile designs more efficient through multiple steps. These include minimizing the drag coefficient caused by the car body's resistance to wind during motion, making the engine more efficient by reducing internal friction which would mean that it wears out slower than is usually the case, while also maximizing the amount of motion produced by a given amount of fuel. These are the goals proposed by the BMW EfficientDynamics automobile designs (BMW).

These models of cars incorporate many electrical parts in their construction, from electrical power steering, to braking. Additionally, these automobiles also inform the driver of when it is time to shift gears so as to make the driving experience more efficient.

#### **IV. Summary and Conclusion**

The BMW automobile corporation has made several endeavors towards the implementation of environmentally friendly models of cars, all of which are directed in an attempt to make the world a less polluted place, as well as to lead the way in the design of more eco-friendly vehicles. Additionally, the company gains from its being viewed by its clients as an environmentally active corporation, which is a positive addition to its own marketing campaigns.

Regardless of whether company aims to use these techniques for monetary gain, which is expectable due to their being a major corporation which aiming for financial stability, the BMW Corporation is making significant efforts to advertise the application of efficient and eco-friendly designs. Such a step should be copied by other car manufacturers finally resulting in better designs and less environmental impact.

After carefully studying the feasibility of BMW's Green Project through research, interviews, and a survey (which is included in the appendix section on page 20), we concluded that it is a possible mission due to many reasons. To start with, BMW has always been known for its exceptional designs and reliable engines and never failed to impress. The technology BMW is using each year to produce their cars is developing and facilitating drivers' lives. As a consequence of their hard and professional work, the German Company has gained international success.

Furthermore, the results of the survey provided vital information concerning the public's opinion about this green project. Most of the people showed that they are willing to be part of this green project, as you will observe in the following section, either by willing to buy BMW's cars or by simply advocating the company's philosophy and steps to accomplish their goals.

However, BMW might face some obstacles in making their green project a reality. First of all, people aren't willing to pay a large amount of money for environmentally friendly cars, so BMW should assign reasonably acceptable prices for such cars. In addition, long-lasting batteries are needed to run those cars, as well as electric chargers placed in public places and on the roads. Unfortunately, this isn't the case nowadays in which technology hasn't offered us such batteries yet, and roadside charges aren't available in a sufficient quantity.

Therefore, we believe that BMW can complete their mission in the near future when the technology of batteries is more advanced and when the roadside chargers are given more attention and consideration, because they have all what it takes to lead a successful green project.

## **V. Appendices**

### **A. Survey**

The questions were:

**1. Gender:**

- Male
- Female

**2. What do you prefer?**

- Electric Powered Car
- Diesel Powered Car

**3. On a scale from one to ten, where does BMW stand?**

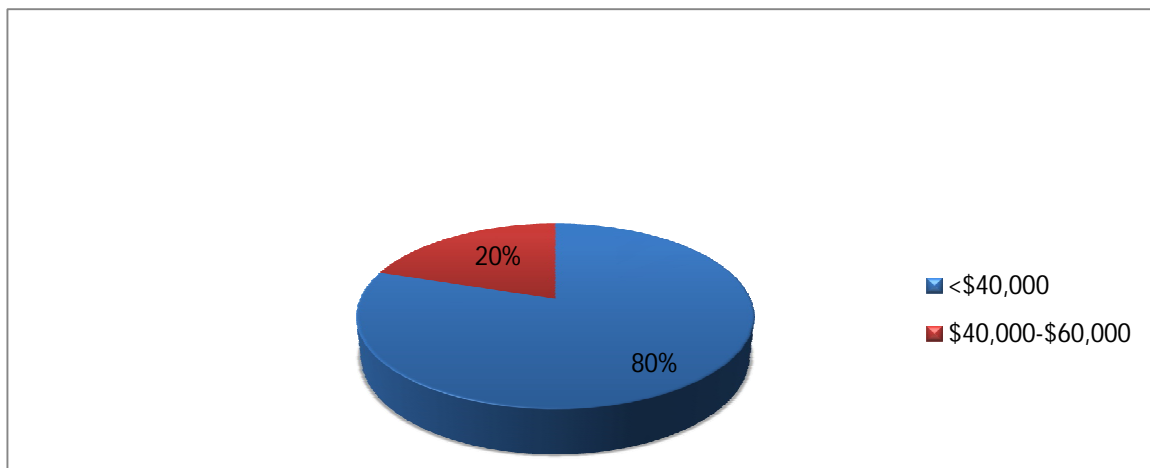
**4. How much are you willing to pay for a BMW electric car?**

- < \$40,000
- \$40,000-\$-60,000
- >\$60,000

**5. Do you think that BMW's Green project (electric cars, hydrogen cars...) will highly contribute to the reduction of pollution or will it have a minor positive impact on the environment?**

## Results and Data Analysis:

- The research was distributed equally between both genders, in which it was conducted among 5 males as well as 5 females.
- 70% preferred diesel cars and the remaining 30% preferred electric powered ones. When asked about the reasons behind their choices, the ones who chose electric cars stated that they are less likely to cause pollution, and that diesel might diminish in the next 50 years so such cars can be suitable alternatives. While the minority who selected diesel cars said that these cars offer more reliable performance.
- 100% of the students ranked BMW on a scale between 7-10. This shows that BMW is widely recognized for its unique cars and engines, and can successfully accomplish a project.
- The amount of money that the students are willing to pay for an electric car is shown in the pie cart below:



**Figure 7.** Percentage of students by sector according to the amount of money they're willing to pay in \$.

**Note:** None of the students was willing to pay more than \$60,000 for an electric car.

The results obtained imply that people aren't willing to pay a large amount of money for an electric car. Therefore, BMW should take into consideration the prices of their hybrid cars, and try to make them cost efficient without risking their ability to produce an effective and useful car.

- 65% of the students thought that BMW's Green Project will highly contribute to the reduction of pollution due to the following reasons:
  1. BMW's international and worldwide reputation reflecting their cars.
  2. BMW's unique designs and cars that resemble excellent performance and durability.
  3. BMW's intelligent and experienced engineers, and their ability to use innovative approaches in creating their models.

The remaining 35% thought that BMW's Green project will have a minor positive impact on the environment because according to them, there are other significant factors contributing to pollution such as factories...

**Note:** It is important to specify here that among the 35% listed above, some of them indicated that the green project can't necessarily result in success, since electric cars for example need batteries that can operate for a long time before they run out, a technology that is not completely available nowadays.

## B. Glossary

- Deforestation (*noun*): the action or process of clearing of forests; *also* : the state of having been cleared of forests.
- Desertification (*noun*): the process of becoming [desert](#) (as from land mismanagement or climate change).
- Greenhouse Effect (*noun*): warming of the surface and lower atmosphere of a planet (as Earth or Venus) that is caused by conversion of solar radiation into heat in a process involving selective transmission of short wave solar radiation by the atmosphere, its absorption by the planet's surface, and reradiation as infrared which is absorbed and partly reradiated back to the surface by atmospheric gases.
- Hybrid (*noun*): something (as a power plant, vehicle, or electronic circuit) that has two different types of components performing essentially the same function.
- Fossil Fuel (*noun*): a fuel (as coal, oil, or natural gas) formed in the earth from plant or animal remains.
- Electrolysis (*noun*): the producing of chemical changes by passage of an [electric](#) current through an [electrolyte](#).
- Carbon footprint (*noun*): the amount of greenhouse gases and specifically carbon dioxide emitted by something (as a person's activities or a product's manufacture and transport) during a given period.



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