Hybrid Cars

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Abstract:-**This paper focused on hybrid vehicle technology and its integration into society. The encompassing issue answered in this project was whether hybrids meet the expectationsfor environme ntal benefits suggested by many people. Research was done is the areas of types of hybrids, consumer trends, and the future of hyb rid technology. Hybrid production and efficiency data were anal yzed to examine the technical aspects of the technology. A focus group of people who recently bought cars, both hybrids and non-hybrids, revealed what consumers look for in their cars. Analysis of the needs of hybrid technology helped determine how feasible widespread change to hybrids would be in future. With all infor mation taken into account, we concluded thathybrids have severa l drawbacks that offset their fuel efficiency. Their higher price bo th turns consumers away and makes the vehicles a less attractive economic investment. Energy efficient processing techniques nee d to be developed before the advanced materials in hybrids can h elp add to their clean image. Widespread change to advanced hyb rid technologies is not a feasible option in the near future because of both costand the limited amount of hybrids on the road today. Overall, hybrid technology has a lot of potential in the distant fut ure, but as for right now they are not a significant improvement o ver today's internal combustion engine.**

I. INTRODUCTION

As modern culture and technology continue to develop, the gr owing presence of global warming and irreversible climate ch ange draws increasing amounts of concern from the world's p opulation. Earth's climate is beginning to transform, proven b y the frequent severe storms, the drastic shrinking of polar ice caps and mountain glaciers, the increased amount of flooding in coastal areas, and longer droughts in arid sections of the wo rld. There are large holes in the ozone layer of the earth's atm osphere and smog levels are ever increasing, leading to decrea sed air quality2. It is true that natural causes such as geotherm al vents and volcanic hotspots are part of the global warming p roblem but many of the issues are still a result of the massive quantities of greenhouse gasses that the world's popul ation has produced in the past few centuries. It has only been within the past few decades that modern society has actually taken notice of these changes and decided that something need s to change if the global warming process is to be stopped, or e ven slowed at this point in time. Countries around the world ar e working to drastically reduce CO2 emissions as well as other harmful environmental pollutants. Everything from cars and i ndustries to livestock and crops are being studied and regulated with plans of minimizing pollution levels. Amongst t he most notable producers of these pollutants are automobiles, which are almost exclusively powered by internal combustion engines and spew out unhealthy emissions. Cars and trucks a re responsible for almost 25% of CO2 emission, and other maj or transportation methods account for another 12%.3 With a global population in excess of six billion, and over 50% of wh om live in urban areas and rely on transportation to contribute to society. In the opinion of many, cars are a large contributor to urban pollutions levels and, in the bigger picture, global war ming. With immense quantities of cars on the road today, pur e combustion engines are quickly becoming a target of global warming blame. Internal combustion engines account for a lo t of the pollution problems, but the issue still stands as to what system will drive the next wave of automotive vehicles.

One potential alternative to the world's dependence on standar d combustion engine vehicles are hybrid cars. Hybrids, like th eir name suggests, are vehicles that utilize multiple forms of fu el to power their engines. In the majority of modern hybrids, c ars are powered by a combination of traditional gasoline powe r and the addition of an electric motor. In this sort of hybrid e ngine, the combustion engine is used at high speeds for long di stances, such as the highway, and the electric engine at low sp eeds and short distances, such as in urban areas. By incorporating alternative energy drive-trains into vehicles that also use combustion engines, they allow for a slightly cleaner mode of transportation. Hybrids however, do still use the petroleum based engine while driving so they are not completely clean, just cleaner than petroleum only cars. This enables hybrid cars to have the potential to segue into new technologies that rely strictly on alternate fuel sources. Just as combustion engines are still being improved, alternate fuel basedtechnologies are making advancements as well. Automotive companies are currently in production of strictly electric cars along with many more designs that are still in the prototype stages. Alternative fuels, such as hydrogen, natural gas, and bio diesel are extensively studied and explored in hopes of widespread future implementation into society. However, many of these alternative fuels will require far too many resources for the world's population to fully convert to within the near future, if at all. Fuel cells would require a complete reinvention of the automobile, not to mention the nation's gas stations, and the technology to put them on the road is still a long way from fruition.4 As is the case with many alternative fuel sources, a great amount of time and money would have to be spent to change the current gas stations so that they are alternative fuel compatible.

II. PROPOSED SOLUTION

The objectives of our paper were to analyze the process of making hybrid cars to see if their production is as clean as their daily use, examine the various economic effects and routes for converting combustion engine vehicles with alternative designs to see if widespread change is feasible, and analyze marketing trends and changes associated with hybrid technology. We used many different methods to gain access to the information we need to fully study these topics. Secondary data, interviews, focus groups and many articles and online sources helped us make educated conclusions to our project questions.

A. Quantitative Data Analysis

Hybrid vehicles are very complex machines that require more materials and work to construct, compared to the standard combustion engine vehicle, due to the fact that they have at least two sources of power. This being the case, one could think that it is only natural that the construction of hybrids creates more harmful gasses than combustion engine vehicles, however by what margin is seldom brought up in many relevant conversations and statistics. We used the MIT study "On the Road in 2020", which includes data on these topics, to help us makes informed decisions about the 'greenness' of hybrids. Using this data, we compared amounts of different materials used in cars, the energy consumption and emission levels used in processing these materials, and the emission levels of cars. Series of calculations were made in Microsoft Excel spread sheets in a precise sequence in order to produce accurate analysis.This produced quantitative results that were used to generate graphs and comprehensive displays, showing timelines on when hybrids becomes 'greener' than a regular ICE's.

B. Energy Consumption Calculations

Our data included what materials go into certain types of cars. The data gave the mass of each material per car as well as the total weight of the car. Our data also included how much energy, in mega-Joules, it takes to process every kilogram or each material. With this data we found out how much energy it takes to produce each type of car. The first set of calculations was to take each material and multiply its mass/car (kg/car) by how much energy it takes to process each kilogram of that material (MJ/kg). This gave us how much energy is used to produce enough of each material for one car. Next, we added up all of the material energy usages to get a total amount of energy used to make the car. In our data, we use two sets of energy consumption values; one for processing new raw material and one for processing recycled materials. Calculations were done for all vehicles in our study and both sets of processing data were used. By doing these calculations we were able to compare quantitatively how much energy, for both primary and secondary processing, goes into making each type of vehicle. An example of the calculation spreadsheet used for each car can be seen below.

Vehicle:	Current, SI ICE, Gasoline, Auto				
	Given Data			Calculated Data	
	Vehicle Mass(kg)	Energy Use, Primary (MJ/kg)	Energy Use, Secondary (MJ/kg)	Energy Use/ vehicle, Primary (MJ)	Energy Use/ vehicle, Secondary (MJ)
Ferrous Metals	886	40	30	35440	26580
Aluminum	81	220	40	17820	3240
Glass	35	30	15	1050	525
Magnesium	10	280	27	2800	270
Copper	9	100	45	900	405
Zinc	7	50	16	350	112
Lead	10	40	8	400	80
Plastics	100	90	45	9000	4500
Rubber	54	70	N/A	3780	#VALUE!
Wood, Felt, etc.	64			0	0
Paint, Coatings	5			0	0
Nickel	0	110	110	0	0
Others	9			0	0
Fluids	54			0	0
Total	1324			71540	35712

C. Breakeven Calculations

In today's car market, many cars have a standard ICE model as well as a hybrid model. In our study we compared many of these vehicles. Break even calculations let you know how many miles need to be driven in order to make the premium price of a hybrid model beneficial. For these calculations we needed to know, for both models, the price of the vehicle, itsgas mileage (both city and highway values were preferred), and then the price of gas (which can be arbitrarily picked and changed to match the current pricing). To find the breakeven point we had to set up an equation that took into account all ofour data at once. The equation compared gas mileage of the standard model to that of the hybrid model and compensated for the increased price. The equation was then solved for the mileage variable which was the same on both sides of the equation. This mileage was the minimum mileage a person would have to drive, in the life of the vehicle, to make it monetarily worth paying for the more expensive hybrid. This equation was used with different values of gas mileage as well as three different types of driving habits. Calculations were done for the following styles of driving: Strictly highway, strictly city, and a one to one ratio of both highway and city driving. The equation used can be seen below.

(Mileage/MPG standard)*(Gas price) = (Mileage/MPG hybrid)*(Gas price) + (Price Difference)

Equation solved for "Mileage" to give the mileage of the Breakeven Point.

III. PROPOSED HYBRID ENERGY SYSTEM

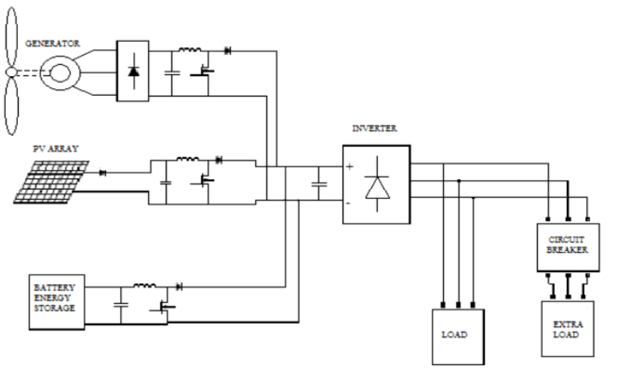

Fig 1: Configuration of Hybrid Energy System

A. Wind Energy Source

The wind turbine captures the wind's kinetic energy in a rotor consisting of two or more blades mechanically coupled to an electrical generator. The equation describes the mechanical power captured from wind by a wind turbine [4] can be formulated as:

Pm = 0.5ρACpv3 (1)

Where: = Air density (Kg/m3)

A = Swept area (m2)

cp= Power coefficient of the wind turbine

v= Wind speed (m/s)

t = Time (sec) T

he theoretical maximum value of the power coefficient cp is 0.59. It is dependent on two variables, the tip speed ratio (TSR) and the pitch angle. The pitch angle refers to the angle in which the turbine blades are aligned with respect to its longitudinal axis. TSR is defined as the linear speed of the rotor to the wind speed.

$$TSR = \lambda = \frac{\omega R}{v} \quad (2)$$

Where: ω= Turbine rotor speed (rad/s)

R= Radius of the turbine blade (m)

v = Wind speed (m/s)

Fig.2 shows a typical "CP Vs. λ" curve for a wind turbine. In practical designs, the maximum achievable ranges from 0.4 to 0.5 for high speed turbines and 0.2 to 0.4 for slow speed turbines. Fig.2 shows that has its maximum value ( ) at λo pt. Which results in optimum efficiency and maximum power is captured from wind by the turbine. Fig. 3 clarifies the output power of a wind turbine versus rotor speed while wind speed is changed from v1 to v4 (v4>v3>v2>v1). Fig. 3 shows that if speed is v1, at rotor speed ω1 maximum power could be captured. While speed increases from v1 to v4, similar to the maximum power point tracking rotor speed is also increases from ω1 to ω4.

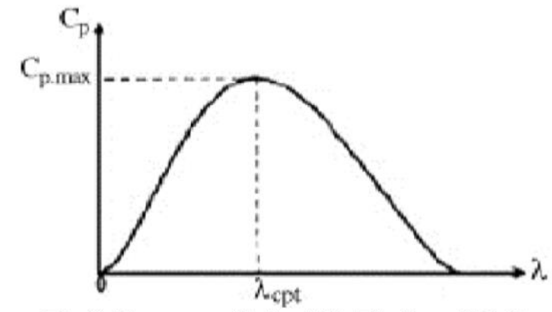

Fig 2: Power coefficient Vs Tip Speed Ratio

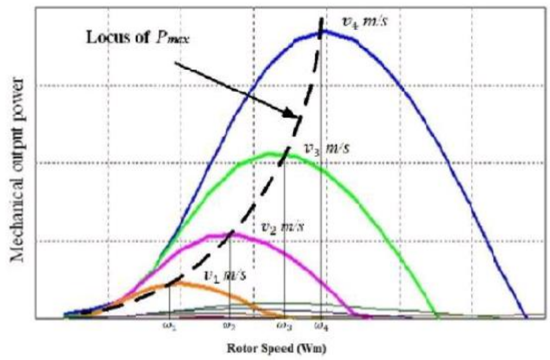

Fig 3: Output Power Vs Rotor Speed of different speeds

For different wind speeds maximum power is generated at a different rotor speeds. Therefore, for every wind speed with the ideal TSR, turbine speed should be controlled. Based on equation (2) the optimum rotor speed can be estimated as follows:

$$\omega_{opt} = \frac{TSR_{opt} V}{R} \quad (3)$$

If C_p is known the torque can be calculated from:

$$T_a = \frac{1}{2} \rho A v^3 C_p / \omega \quad (4)$$

Substituting (2) in (4), the torque can be written as: For below rated wind speed:

T = $k_{opt} \omega^2$

Where: $k_{opt} = \frac{1}{2} \rho A C_p \left(\frac{R}{\lambda}\right)^3$ (6)

For above rated wind speed:

$$T = P_{rated}/\omega; \quad \text{for } P \geq P_{rated}$$

B. Photovoltaic (PV) System

A solar cell is the most fundamental component of a photovoltaic (PV) system. The PV array is constructed by many series or parallel connected solar cells to obtain required current, voltage and high power [8]. Each Solar cell is similar to a diode with a p-n junction formed by semiconductor material. When the junction absorbs light, it can produce currents by the photovoltaic effect. The output power characteristic curves for the PV array at an insolation are shown in Fig. 4. It can be seen that a maximum power point exists on each output power characteristic curve. The Fig: 5 shows the (I-V) and (P-V) characteristics of the PV array at different solar intensities. The equivalent circuit of a solar cell is the current source in parallel with a diode of a forward bias. The output terminals of the circuit are connected to the load. The current equation of the solar cell is given by:

$$I = I_{ph} - I_D - I_{sh}$$

$$I = I_{ph} - I_0[\exp(\frac{qV_D}{nkT})] - \frac{V_D}{R_{SH}}$$

Where:

Iph = Photo current (A)
ID = Diode current (A)
Ish = Shunt current (A)
VD = Voltage across diode (Volt)
I0 = Diode reverse saturation current (A)
q = Electron charge = 1.6X10-19 (C)
k = Boltzman constant = 1.38X10-23 (J/K)
T = Cell temperature (K)
Rs = series resistance (Ω)
Rsh = shunt resistance (Ω)

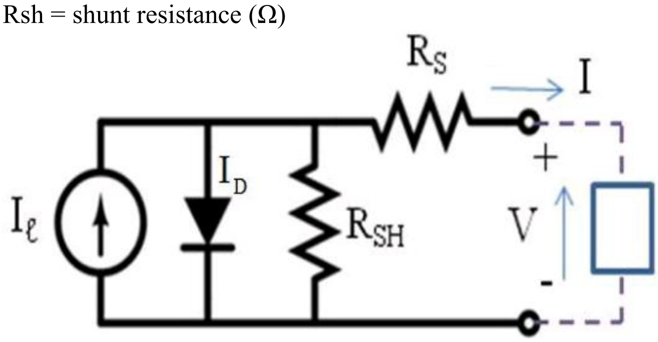

Fig 4: Equivalent circuit of PV Module

The power output of a solar cell is given by
Ppv = V * I
(9) Where: I = solar cell output current (A)
V = Operating voltage of solar cell (volt)
Ppv =Output power of solar cell (W)

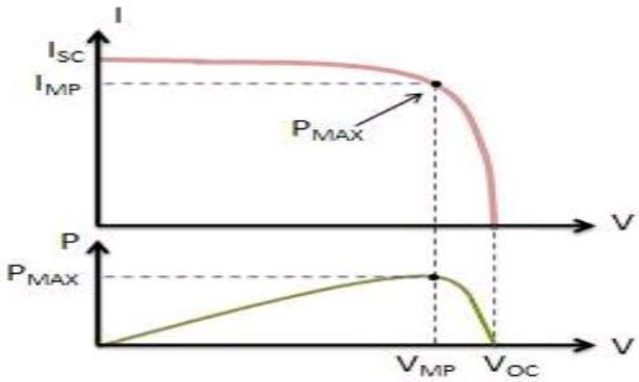

Fig 5: Output characteristics of PV Array

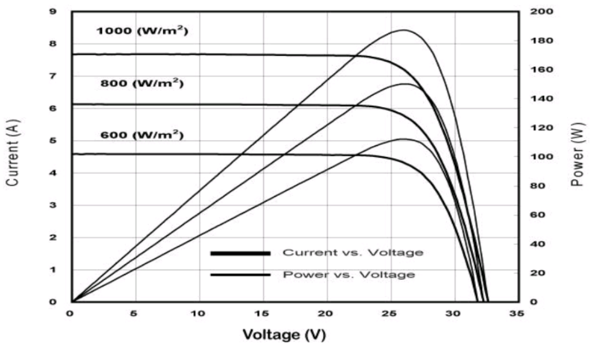

Fig 6: I-V and P-V Characteristics of PV Array at different solar intensities

VI. MODELS FOR IMPLEMENTATION

Fig: Basic Model

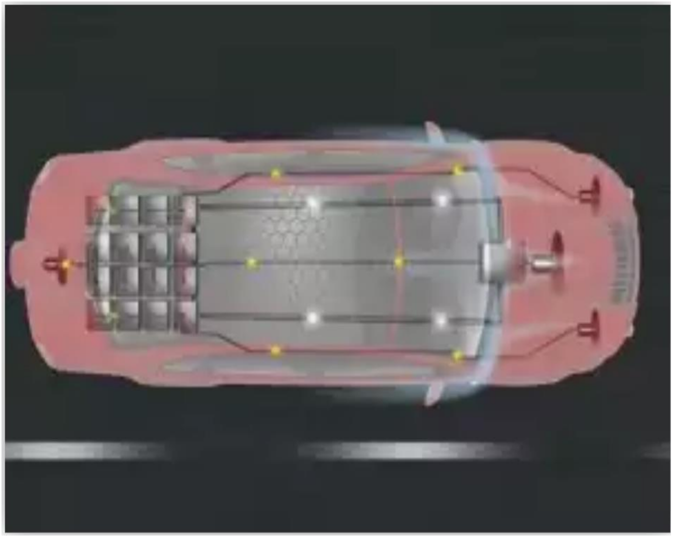

Fig: Power Flow

V. CONCLUSIONS

Do hybrids meet the expectations that society has suggested of them in the past decade? That is the main question that we set out to answer in this paper and it has many factors that have to be taken into account to answer it.People that buy cars need to know what they want in a car, choose the right car, and be aware of the investment that they are entering into.Car manufa cturers and dealerships need to understand the consumer needs and habits before trying to sell hybrids.Yes, the technology is advancing and has potential but it has to be used correctly to work effectively.Overall, hybrids really do not live up to their expectations. First of all, for cars that are supposed to be more environmentally friendly hybrid create much more emission b efore they even hit roads. The production of hybrids is far mo re harmful than the production of today's regular ICE's.In so me cases, hybrids consume four times as much energy in prod uction,and in turn are responsible for fourtimes as much harmf ul pollution that is released into the atmosphere, when compar ed to non hybrids.

It is easy to jump to the conclusion that a hybrid which gets be tter gas mileage than a nonhybrid will save the consumer mon ey, but initial costs must be taken into account. If the increase d initial cost of a hybrid is too much, the investment will be ve ry hard to break even with. Hybrids must be driven to high mi leages in certain conditions to really be worth paying for. The se mileages are often even with, or many times higher than, th e average mileage that a consumer keeps their car for. The spe cific driving condition in which a hybrid is effective is in all ci ty driving. This makes it even harder for a consumer to rack u p at least 150,000 miles to justify the high cost of the car. An yone whose driving exceeds the low speeds of city driving is s ubstantially increasing the mileage in which they will have to drive in order to break even.

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