

Hybrid electrical vehicles for India – A Review

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Abstract: In recent years, pollution due to CO₂ emission has been increasing very fast. Hence HEV's have received much attention years for their significant impact in reducing pollution and overall fuel cost. Increasing fuel consumption problem can be solved by HEV's. regenerative braking is used in HEV's which is very useful in India's stop and go traffic

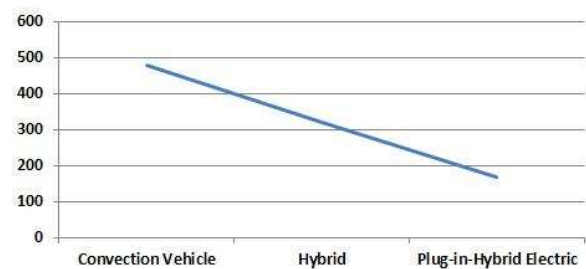
I. INTRODUCTION

Hybrid vehicle is a vehicle that uses two or more distinct power source to move the vehicle from one place. In Hybrid electrical vehicle, there is combination of internal combustion engine, battery and one or more electrical motors[1]. In 1901, Ferdinand Porsche developed first Hybrid car named as Lohner-Porsche mixte hybrid that was first Gasoline-electric hybrid automobile. Afterwards, Toyota Company of Japan developed Toyota Prius which is widely used nowadays. For example we can use following Power Sources Gasoline, Hydrogen, Ethanol, Biomass, Electricity, solar and many more. By using hybrid vehicle CO₂ emission up to 35% can be reduced with the use of CNG reduction in fuel consumption is reduced by 10% and switching from petrol to diesel gives 20% reduction in total fuel consumption, but as compare to these, hybrid vehicle gives 30% reduction in fuel consumption. Fuel consumption depends upon driving conditions. India having more stop and go traffic conditions there will be greater potential for fuel savings using hybrid vehicles. This is useful for city bus and delivery trucks.

Need

Here comes the topic of need, as our conventional vehicles are on the various fossil fuels which are declining very fast in nature and with the very less efficient than our expectation. All these problems are fully covered in the case of hybrid vehicles. Additional advantage is also reduction in environmental pollutions.

**Oil consumption, PHEVs Compared to
Other Mid-Sized cars**



An electric-powered car cannot go more than 100 miles (161 km) between recharging, is difficult to re-charge and doesn't drive beyond 60 mpg, although it emits little pollution. Hence, Hybrid Vehicles[3]. It increases drive train efficiency about 30-40%. It reduces emission and increases fuel economy. While talking about vehicle we also have to mention its power which is significantly increased in case of Hybrid vehicle by enhancing its drive train efficiency.

Current scenario

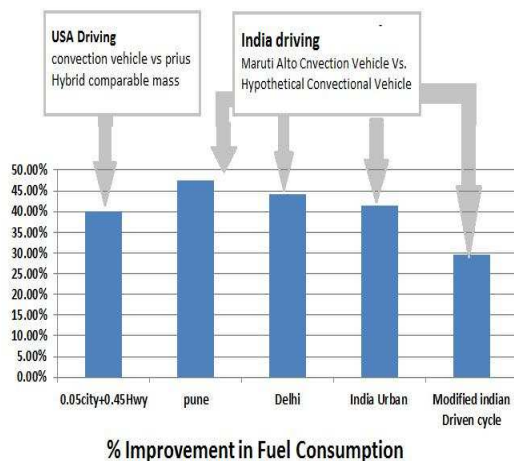
Auto analysis believe that sales volume of the automobile companies will get a boost after finance minister left more money in hands of salaried employees. After the announcement of budget plan two wheeler sales volumes will like to grow by 12% from earlier estimate of 8%[3]. Companies such as Hero

motocorp , maruti and TVS motor will be beneficial for
budget announcement .Luxury car companies like
Mercedes benz(sedan CLA 45), BMW(7 sedan)

,Porche(macan) are interested to invest in hybrid vehicle In July 2014, Bajaj Auto company sale rises by 3% And 14.76% rise in Domestic passenger car[7]. In India, Volkswagen plans for investment up to Rs. 1500-cr.Bajaj auto reports marginal rise in Q1 profit at Rs 740 cr.Hero motocorp sales up 6% in May[3].

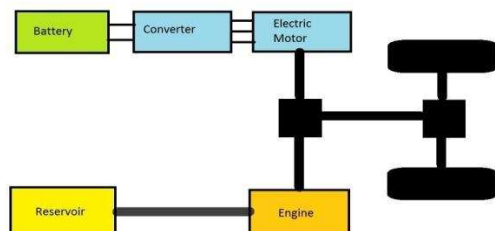
MID RANGE CAR LAUNCH

Name of company with model	Price(in lakhs)
Honda (MPV mobilio)	6.4
Nissan(New Sunny)	7.29
Ford India (fieasta)	7.69
Mahindra(XUV 500)	13.68



II. TYPES OF CONFIGURATONS

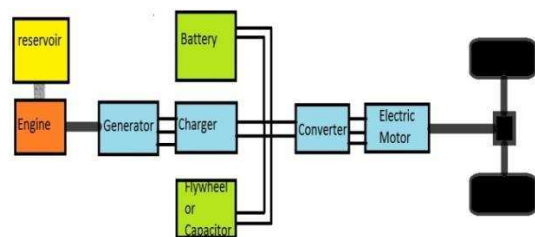
Parallel configuration:



It includes two separate power paths; the mechanical path and electrical path. Each power path can drive vehicle individually or collaboratively. Power flows to wheels in parallel. Both engine and electric motor drives wheels and power from both these source can be utilized according to prevailing condition[7] Example: Civic Hybrid from Honda.

Series Configuration:

Only applies in motor to drive the wheels. The motor power is supplied by either a battery or a generator transforming engine power into electric power or both. since engine operation is independent of vehicle speed and road load, it can operate near its optimal condition almost all the time[7]. Example: 2014 BMW i3 and 2012 Fisker karma.

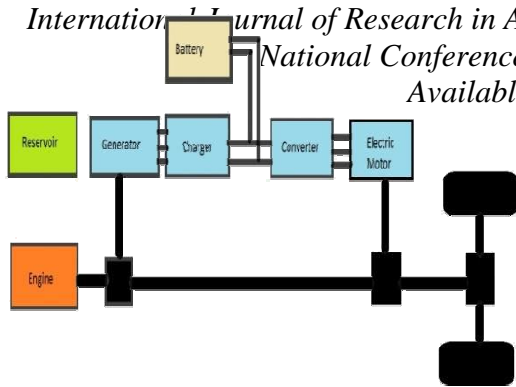


A series hybrid vehicle is an electric vehicle with an onboard battery charger. An ice generally runs at an optimal efficient point to drive the generator and charge the propulsion batteries onboard the vehicle. Less energy transfer is there between engine and wheels.it can meet instantaneous power needs. It allows for small electrical system it has a simple drive train.it can run as purely electrical vehicle.

Series/Parallel Hybrid Configuration:

It has two motor depending on driving condition it uses only electric motor or driving power from both electric motor and engine in order to achieve the highest level.

Furthermore when necessary the system drives the wheels while simultaneously generating electricity using a generator. Example: Fords CMax and Fusion Hybrids , all Toyota & Lexus.



which is controlled by engine, but while engine is off all the accessories operated with the electrical power. There is no regenerative braking. Very small amount of operation depends upon the electrical

III. TYPES OF HYBRID LEVEL

Strong hybrid

It has only battery or engine or combination of both. It required large capacity of battery. Total operation of the system depends upon battery. Eg. Toyota prius

Medium hybrid

This system content engine and motor, but engine is a primary source in the total system. This system is also called as „motor assist hybrid“. Engine and motor are connected in parallel. Electrical vehicle mode operation is for small duration and it is not standard. As compared to full hybrid requirement of power from electrical source is less, so the battery capacity is lesser than the full hybrid. Motor is placed between engine and transmission so it requires large motor start. There is a regenerative braking of motor, i.e. motor act as generator.

Mild/ micro hybrid

The system has a start and stop with energy recuperation. This is the conventional vehicle with oversized starter motor. Whenever car stops, coasting or braking allows the engine to turn off. It has easy starting by motor which have high rpm rating and is going to start before the combustion engine start for ignition. This system is having various accessories like air conditioner

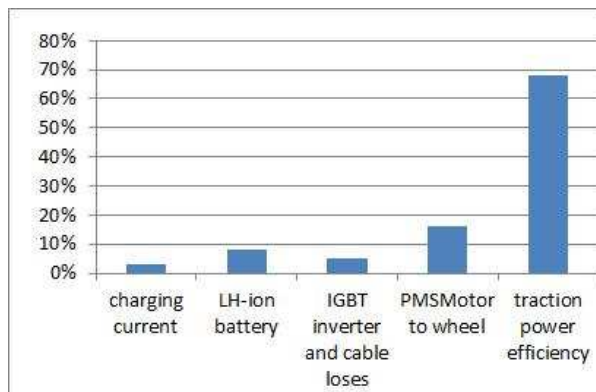
power. Due to this micro hybrid not called as hybrid. Day by day efficiency of engine is going to reduce. Example: 2013 honda civic

Plug in hybrid

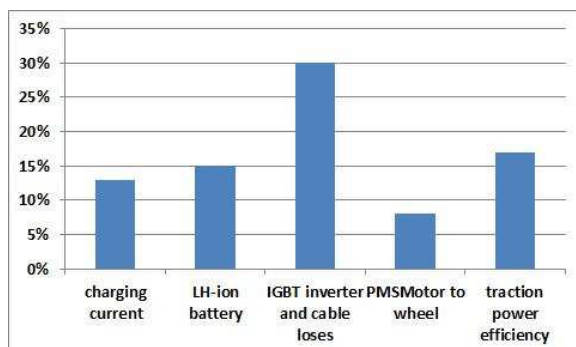
It is having a rechargeable battery source. Total system has capacity to operate on electrical power source. In this system operation motor act as primary power source and gasoline engine is secondary or supplementary[2].

The following graphs show the total current consumption from grid and Traction power efficiency of plugged EV.

(1) Battery powered plug in EV (Mitsubishi Lancer Evolution MIEV)



(2) A fuel cell EV (Mercedes NECAR3)



Battery requires high charging storage capacity. It is having various modes of operations as charge depletion, charge sustaining and mixed mode. It is having 3 main

features as refueling, energy storage and propulsion. Driving is mostly depending on electrical power until the battery is discharged. Eg. Ford fusion energy, Toyota prius Honda accord

Battery charging

It contains solid electrolyte and high energy density. One more good point is that weight of the Li-ion battery is half of the NiMH. Less space is required for the battery due to its compact size. Open circuit voltage of approximately 3v to 4v at full charger and having less discharge time. Li-ion battery is more environments friendly. Recharging with 120V household power supply it takes several hours for charging and with 240v supply it takes 1-4 Hours charging. Quick chargers take 30 min to achieve 80% charging[6].

Motor

For manufacturing HEV Vehicles various motors are available like Permanent Magnet Synchronous Motor, Brushless DC Motor, Switch Reluctance Motor, AC induction Motor and so on. But for regenerative braking motor requires to be run as a generator .for that Permanent magnet motor is preferred[5]. The entire HEV vehicle basically has a regenerative mechanical braking. The motor requires full torque at low speed and it requires flexibility in voltage fluctuation. Toyota basically used AC synchronous Motors (TS 2).

regenerative braking motor operates as generator. The system is particularly effective in recovering energy during city driving. Regenerative braking reduces friction loss. While using footbrake lots of energy is

Total losses in the motor	Permanent Magnet Motor	Copper Rotor Induction Motor
City driving over 120,000 miles	1270	2240kWh
Highway driving over 120,000 miles	610	1250
Aggressive driving over 120,000 miles	1430	2510
Combined average losses	1100	2000
Efficiency	92%	88%
stator copper losses	780W	940W
Rotor losses	0	230W
Total losses	880W	1490W
Max. winding temp.(in Degree)	156	156

[4]

IV. REGENERATIVE BRAKING

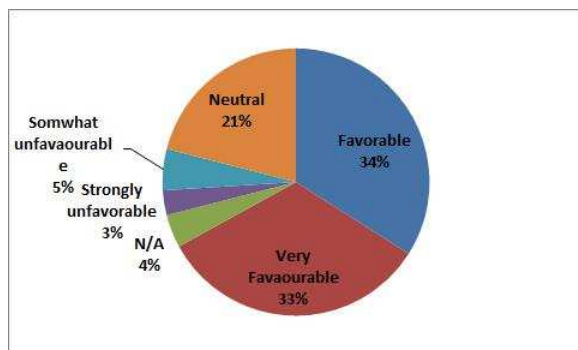
The electrical motor applies resistance to the drive train causing the wheels to slow down.in return the energy from wheels turns the motor which function as a generator converting energy normally wasted during the coasting and braking into electricity which is stored in the battery until needed by electrical motor. In

wasted. This waste of energy can be converted into electrical energy. In the regenerative braking there is recovering energy even at lower vehicle speeds.

V. FUTURE TREND

Green technology is the main moto at the current auto expo with automakers including Maruti Suzuki, Hyundai Motors, Nissan, Mahindra and Mahindra and Hero Motocorp lining up electric and hybrid vehicles for future launch. Hybrid is the technology for tomorrow. We aim to raise awareness of hybrids.

model[7]. Battery is the main key point in the HEV technology. There is also inclusion of traction batteries for this purpose. Their salient features are-



In 2016, the upcoming cars are:-

- Avalon Hybrid
- Camry Hybrid
- Toyota Prius
- Toyota Prius V

In future we will mostly focus on the following points in case of hybrid cars;

- Future in Hybrid Technology
- Environment Friendly
- Fuel Efficiency
- Reduced Noise
- Better Performance
- Financial Benefits For the Government of respective country

Considering all the above points Mahindra And Mahindra launched their REVA NXP hybrid vehicle

- One charge to produce a long range of mileage.
- Stable power with deep discharge characteristics to allow for acceleration and ascending power capability of hybrid vehicles.
- Long life cycle with maintenance free.
- Solves problem of global warming and reduces oil dependence.

Comparison of various hybrid vehicles

Hybrid vehicle	Avg mpg difference	Yearly gas difference	Vehicle cost difference	Gas diff \$3/gal	Years to break even	Gas diff \$6/gal	Years to break even
Prius-corolla	19	189	\$5559	\$566	10	\$1133	5
Ford fusion hybrid FWD	12	176	\$6450	\$529	12	\$1059	6
Honda Civic hybrid	13	147	\$8400	\$441	19	\$882	10
Lexus HS 250h	10	165	\$1600	\$496	3	\$991	2
Nissan Altima hybrid	7	104	\$3860	\$313	20	\$626	10
Ford Escape hybrid FWD	8	138	\$4800	\$415	12	\$831	6
Mazda tribute hybrid 2WD	8	138	\$7310	\$415	18	\$415	9
Toyota Camry hybrid	8	98	\$2000	\$293	7	\$586	3
BMW Active hybrid X2	2	104	\$20000	\$313	64	\$625	32
Mercedes benz S400 hybrid	4	123	\$3000	\$368	8	\$737	4
Chevrolet Tahoe hybrid 4WD	7	302	\$7000	\$907	8	\$1814	4
GMC sierra 15 hybrid 4WD	4	136	\$13000	\$407	32	\$814	16
Chevy Silverado 15 hybrid 4WD	4	136	\$11000	\$407	27	\$814	14
GMC Yukon 1500 hybrid 2WD	4	136	\$9500	\$407	23	\$814	12
Chevrolet Tahoe hybrid 2WD	7	302	\$5000	\$907	6	\$1814	3

Expectations from next generation hybrid cars are-

- Ensure air quality benefits
- Clean up electric power plants establish programs for battery recycling
- Encourage off-peak battery charging

- Hybrid vehicles should be affordable to middle class people.
- Performance of batteries should be same in all weathers.
- Weight of vehicle should be less.
- Driving experience must be smooth.
- Vehicles should be more specious.
- Batteries should be pollution less and environment friendly.
- Maintenance cost should be less.
- Charging stations should be installed in urban areas.

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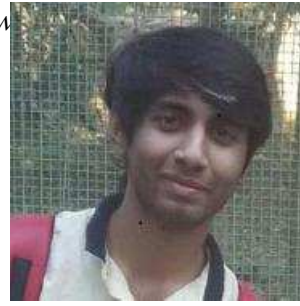
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