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Electric Vehicle: A Project Review

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***Abstract-** In past years, burning of conventional fuel i.e. fossil fuels in transportation, industries and in power sector caused air pollution which is becoming a significant challenge for the world. With this aim of towards green and clean India, this project of Electric Vehicle would be the next step.*

The report consists of object, principle used, development in the field of Electric Vehicle, its type, research, challenges, advantages, and disadvantages. Even in further chapters the report describe about the project and its components, software used for simulation and its output.

The main objective is all about the scope and trend in India. In conclusion we can predict the upcoming market and widespread of technology in the modern world.

I. INTRODUCTION

The development in Electric Vehicles has geared up as present time more concern has been shown in environmental protection and energy conservation. In 21st century, electric vehicle are considered as green transportation because of its environmental protection performance characteristics. Electric vehicle is a research domain in automotive manufacturers, environmental organization and government. It is zero pollution exhausting; it can radically decrease the emissions and help to improve environmental structure. Therefore, it is believed that electric vehicles should be vigorously developed in the country, but large-scale electric vehicle charging has become a practical problem in grid operation and distribution network planning. It may have a significant impact on system performance, such as overload, reduced efficiency, reduced power quality, and increased

	EV	HEV	FCV
Propulsion	Electric motor drives	Electric motor drives Internal combustion engines	Electric motor drives
Energy storage subsystem	Battery Supercapacitor	Battery Supercapacitor Fossil or alternative fuels	Hydrogen tank Battery/supercapacitor needed to enhance power density
Characteristics	Zero local emissions High energy efficiency Independent of fossil fuel Relatively short range High initial cost Commercially available	low local emissions High fuel economy dependence on fossil fuel long driving range Higher cost than ICE vehicles Commercially available	Zero local emissions High energy efficiency Independent of fossil fuels(if not using gasoline to produce H2) High cost Under development
Energy source infrastructure	Electrical grid charging facilities	Gasoline station Electrical grid charging facilities(for pulg-in hybrid)	Hydrogen
Major issue	Battery sizing and management Charging facilities Cost Battery life time	Battery sizing and management Control, optimization and management of multiple energy sources	Fuel cell cost, life cycle and reliability Hydrogen production cost

power system losses. As light fleets turn to electric drives (hybrid, battery, and fuel cell vehicles), "vehicle-to-network" (V2G) power opens up opportunities. V2G only makes sense when the vehicle and the power market match.

II. TYPES OF EV

There are three main types of electric vehicles (EVs), classed by the degree that electricity is used as their energy source.

Hybrid Electric Vehicles (HEVs)

Hybrid cars are driven by gasoline and electricity. Electricity is generated by the car's own braking system to charge the battery. This is called "regenerative braking". In this process, the electric motor helps the vehicle slow down and uses energy that is usually converted into heat by the brake.

Hybrid cars use an electric motor to start, and then the gasoline engine cuts in as the load or speed increases. The two electric motors are controlled by an internal computer to ensure the best economical driving conditions.

Honda Civic Hybrid and Toyota Camry Hybrid are examples of hybrid vehicles.

Plug-in Hybrid Electric Vehicles (PHEVs)

Also known as Extended Range Electric Vehicle (EREV), this type of EV is driven by gasoline and electricity. PHEV can charge the battery through regenerative braking and "plugging" into an external charging socket. In EREV, the gasoline engine expands the driving range of the car by charging even when the battery is low. The changes in these electric vehicles depend on the choice of primary energy source. For example, Toyota Prius prefers gasoline, while our new fleet, Mitsubishi Outlander PHEV (partial sedan electric vehicle) prefers electricity.

III. CHALLENGES

Harmonic Control

Converters are responsible for harmonics generation, so we can change number of PWM converters.

We can also add reactive power compensator. We can use power quality monitoring system which can handle unexpected situations. data and deal with unexpected situations in time.

Coordinated Charging

Coordinated charging requires dispatching and coordinating distributed electric vehicles for charging, but it is very difficult for grid companies to directly control the charging process of each electric vehicle. Therefore, some studies have proposed the concept of "middle man". Others believe that coordinated charging will use multi-agent technology. The combination of electric vehicles and smart grid technology can automatically avoid peak charging time.

IV. PRINCIPLE OF BLDC MOTOR

BLDC motor also works on the same principle as that of DC motor. When current carrying conductor is placed inside a magnetic field, a force act over it, which results in magnet to have equal and opposite force. In BLDC motor we have stator with conductor and rotor with permanent magnet.

When current flows in stator winding, it behaves as a electromagnet and create a uniform electric field. Though, the input supply is DC, the witching produces pulsating AC voltage. The rotor continuously moves due

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to attractive and repulsive force created between the permanent magnet and electromagnet.

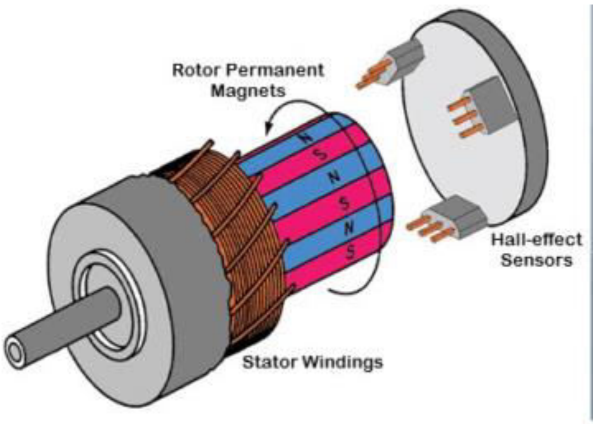


Fig 1. Construction of BLDC

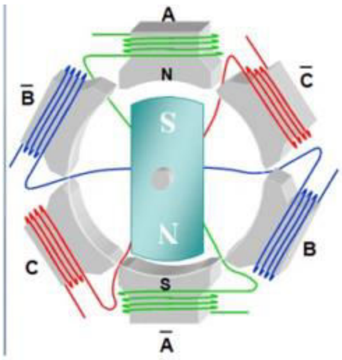


Fig 2. Construction of BLDC

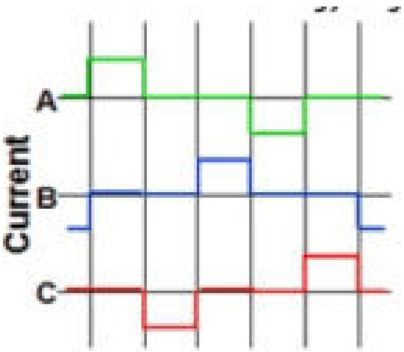


Fig.3 BLDC Motor Current Characteristics

V. PROCEDURE FOR SELECTION OF MOTOR

Let,

$$F_r = C * \omega$$
$$\omega = Ma$$

where, M = mass of body in Kg
a = acceleration of gravity (9.81 m/s^2) C= 0.002 on concrete road
C=0.004 on asphalt road

$$F_r = 0.004 * 90 * 9.81 = 3.5316\ N$$
$$F_r = 3.5N$$

$$F_d=(1/2)C_d * p*V^2*A$$

Where, F_d = Drag Force (N)
C_d=Drag Coefficient
p=Fluid Density (1.2kg/m^3 for air)
V=Flow velocity (m/s)

A=Characteristic frontal area of body(m^2) =1.5 * 0.4 (Height * width)
=0.6m^2

$$F_d= 0.9*(1/2)*1.2*(11.11)^2 *0.6$$
$$= 39.99\ N \quad \text{or } 40\ N$$

$$F_t = F_r + F_d$$
$$P=F_t *V/n$$

where P= Power (W)
F_t= Total Force

n=Efficiency

$$P = (3.5+40)*11.11/0.85$$
$$=568.57W$$
$$P = 600\ W$$

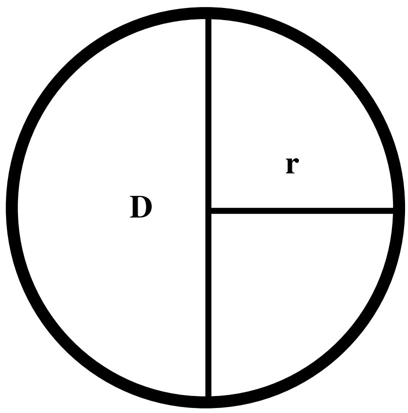


Fig 4. Diagram for a Wheel

D=0.5m
r=0.25m

C=2πr
=2*3.14*0.25
=1.57m

For one revolution of wheel, we will cover the distance of 1.57m,

40km/h= 40000m/h = 40000/60 m/min
= 666.6 m/min

Wheel RPM = 666.6/1.57
= 424.5 = 424 RPM

Motor RPM (including Hub Motor) = gear ratio *wheel RPM
= (Driven/Driver) * 24(Teeth ratio)
= (21/9)*424

Motor RPM = 989 rpm

Torque (Nm) = 9.54* Power /Speed
= 9.54 *568 / 989
Torque = 5.48 Nm

For Maximum Torque let, (0-40 km) in 20 sec,

Then, we know,

v=u + at

where, v= final velocity, u= initial velocity a=acceleration, t= time taken

11.11= 0 + (a*20)

a=0.55 m/s^2

then,

F=ma
F= 90 * 0.55
F=49.5 N

Torque max = F*r
=49.5 *0.25

= 12.375 Nm

Hence from Above considerations, the minimum rating of motor we require will have following specifications:

Power = 600 W
RPM= 1000
Torque max= 12 Nm

Hence, we have selected a motor with

Power = 900 W
RPM= 2000
Torque max= 30 Nm

VI. SIMULATION OF BLDC MOTOR IN MATLAB [7]

Mathematical Modeling

$V_a= i_a R_a+ L_a\, di_a/dt + M_{ab}\, di_b/dt + M_{ac}\, di_c/dt + e_a$ ……………………………………… Eq(1)

$V_b= i_b R_b+ L_b\, di_b/dt + M_{ba}\, di_a/dt + M_{bc}\, di_c/dt + e_b$ ……………………………………… Eq(2)

$V_c= i_c R_c+ L_c\, di_c/dt + M_{cb}\, di_b/dt + M_{ca}\, di_a/dt + e_c$ …………………………………………. Eq(3)

Where, R_a, R_b, R_c - Stator resistance of phase a, b and c.
L_a, L_b, L_c - Stator inductance of phase a, b and c.
i_a, i_b, i_c -Stator current of phase a, b and c
V_a, V_b, V_c -Voltages of phase a, b and c.

$R_a = R_b = R_c = R$ -Mutual inductance between phases
L_a ,L_b, L_c -Stator self-inductance of phase a, b and c.
In this case, $L_a = L_b = L_c = L$

$M_{ab} = M_{bc} = M_{ac} = M_{ba} = M_{ca} = M_{bc} = M$

Assuming three phase balanced system, all phase resistance are equal.

$R_a = R_b = R_c = R$

Let us rearrange the above equations 1, 2 and 3. We get,

$V_a = i_a R + L\, di_a/dt + M\, di_b/dt + M\, di_c/dt + e_a$ ……………….……………………….…… Eq(4)

$V_b = i_b R + L\, di_b/dt + M\, di_a/dt + M\, di_c/dt + e_b$ ………………………….………………………… Eq(5)

$V_c = i_c R + L\, di_c/dt + M\, di_b/dt + M\, di_a/dt + e_c$ …………………………….……………………… Eq(6)

Let us neglect mutual inductance in equations 4, 5 and 6. We get,

$V_a = i_a R + L\, di_a/dt + e_a$ ………………… Eq(7)

$V_b = i_b R + L\, di_b/dt + e_b$ ………………… Eq(8)

Trapezoidal back emf and to be supplied with quasi-rectangular shaped currents. The back emf is generated in each winding of the BLDC motor during rotor rotation and opposes supplied voltage in the main windings. Hence the polarity of the back electromotive force is opposite to energized voltage. The phase winding of stator is displaced by 120 degree each. The windings are distributed such a way that it produces trapezoidal back electromotive force. By energizing the phase pairs, the

PMBLDC motor produces constant torque. In order to produce constant torque the trapezoidal

$V_c = i_c R + L\, di_c/dt + e_c$ ………………… Eq(9

Trapezoidal Back emf

According to Lenz's law each winding of the brushless DC motor generates back emf which opposes main voltage supplied to the winding. The polarity of this back emf is in opposite direction of the energized voltage. Back In case motor is running beyond the rated speed. Back emf may increases. So potential difference is decreased across the winding and also reduces. Actually, current drawn makes in drooping torque curve. In general, PMAC motor is classified in to two types.

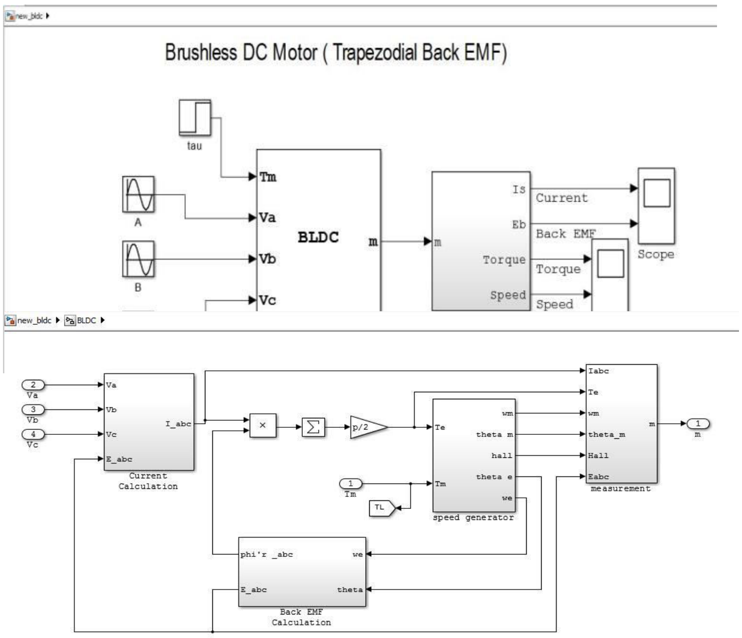


Fig.7. Back EMF and phase current waveform of BLDC motor

back emf is synchronized with quasi square

waveform by controlling the three phase currents. The instantaneous back emf in brushless DC is written as, *Ea* =*fa* (θ)**Ka* * ω ……………….*Eq*.(10)

Eb =*fb* (θ)**Kb* * ω ……………….*Eq*.(11)

Ec =*fc* (θ)**Kc* * ω ……………….*Eq*.(12)

θ -Mechanical speed of rotor

ω -Electrical position of rotor

By assuming the identical back emf for all three phases modelling of back electromotive force is done. The numerical expression of the back emf is obtained based on rotor position. So the symmetric three phase back electromotive force waveforms are generated at every operating speed with rotor position and speed command. The back electromotive force in the windings are represented as follows, *f c* (θ) with limit values between -1 & 1. By substituting E=1 in equations 13, 14 and 15. We get,

$$e_a = \begin{bmatrix} \left(\frac{6E}{\pi}\right)\theta & \left(0<\theta<\frac{\pi}{6}\right) \\ E & \left(\frac{\pi}{6}<\theta<\frac{5\pi}{6}\right) \\ -\left(\frac{6E}{\pi}\right)\theta+6E & \left(\frac{5\pi}{6}<\theta<\frac{7\pi}{6}\right) \\ -E & \left(\frac{7\pi}{6}<\theta<\frac{11\pi}{6}\right) \\ -\left(\frac{6E}{\pi}\right)\theta-12E & \left(\frac{11\pi}{6}<\theta<2\pi\right) \end{bmatrix} \rightarrow Eq.(13)$$

$$e_b = \begin{bmatrix} -E & \left(0<\theta<\frac{\pi}{6}\right) \\ \left(\frac{6E}{\pi}\right)\theta-4E & \left(\frac{\pi}{2}<\theta<\frac{5\pi}{6}\right) \\ E & \left(\frac{5\pi}{6}<\theta<\frac{9\pi}{6}\right) \\ -\left(\frac{6E}{\pi}\right)\theta+10E & \left(\frac{9\pi}{6}<\theta<\frac{11\pi}{6}\right) \\ -E & \left(\frac{11\pi}{6}<\theta<2\pi\right) \end{bmatrix} \rightarrow Eq.(14)$$

$$e_c = \begin{bmatrix} -E & \left(0<\theta<\frac{\pi}{2}\right) \\ -\left(\frac{6E}{\pi}\right)\theta+2E & \left(\frac{\pi}{6}<\theta<\frac{\pi}{2}\right) \\ -E & \left(\frac{\pi}{2}<\theta<\frac{7\pi}{6}\right) \\ \left(\frac{6E}{\pi}\right)\theta-8E & \left(\frac{7\pi}{6}<\theta<\frac{9\pi}{6}\right) \\ E & \left(\frac{9\pi}{6}<\theta<2\pi\right) \end{bmatrix} \rightarrow Eq.(15)$$

$$f_a(\theta) = \begin{bmatrix} \left(\frac{6}{\pi}\right)\theta & \left(0<\theta<\frac{\pi}{6}\right) \\ 1 & \left(\frac{\pi}{6}<\theta<\frac{5\pi}{6}\right) \\ -\left(\frac{6}{\pi}\right)\theta+6 & \left(\frac{5\pi}{6}<\theta<\frac{7\pi}{6}\right) \\ -1 & \left(\frac{7\pi}{6}<\theta<\frac{11\pi}{6}\right) \\ -\left(\frac{6}{\pi}\right)\theta-12 & \left(\frac{11\pi}{6}<\theta<2\pi\right) \end{bmatrix} \rightarrow Eq.(16)$$

$$f_b(\theta) = \begin{bmatrix} -1 & \left(0<\theta<\frac{\pi}{6}\right) \\ \left(\frac{6}{\pi}\right)\theta-4 & \left(\frac{\pi}{2}<\theta<\frac{5\pi}{6}\right) \\ 1 & \left(\frac{5\pi}{6}<\theta<\frac{9\pi}{6}\right) \\ -\left(\frac{6}{\pi}\right)\theta+10 & \left(\frac{9\pi}{6}<\theta<\frac{11\pi}{6}\right) \\ -1 & \left(\frac{11\pi}{6}<\theta<2\pi\right) \end{bmatrix} \rightarrow Eq.(17)$$

$$f_c(\theta) = \begin{bmatrix} -1 & \left(0<\theta<\frac{\pi}{2}\right) \\ -\left(\frac{6}{\pi}\right)\theta+2 & \left(\frac{\pi}{6}<\theta<\frac{\pi}{2}\right) \\ -1 & \left(\frac{\pi}{2}<\theta<\frac{7\pi}{6}\right) \\ \left(\frac{6}{\pi}\right)\theta-8 & \left(\frac{7\pi}{6}<\theta<\frac{9\pi}{6}\right) \\ 1 & \left(\frac{9\pi}{6}<\theta<2\pi\right) \end{bmatrix} \rightarrow Eq.(18)$$

Torque Generation

Theoretical motor constant ‘Kt’ is the product of torque and supply current ‘I’.

$$Ta = Tb = Tc$$

$$Kt(motor) = Kt(a) + Kt(b) + Kt(c)$$

$$i\,motor = i\,a = i\,b = i\,c$$

$$\theta = \text{Angle}$$

$$Ta, Tb, Tc = \text{Total torques}$$

$$D\theta/dt = (P/2)*\omega$$

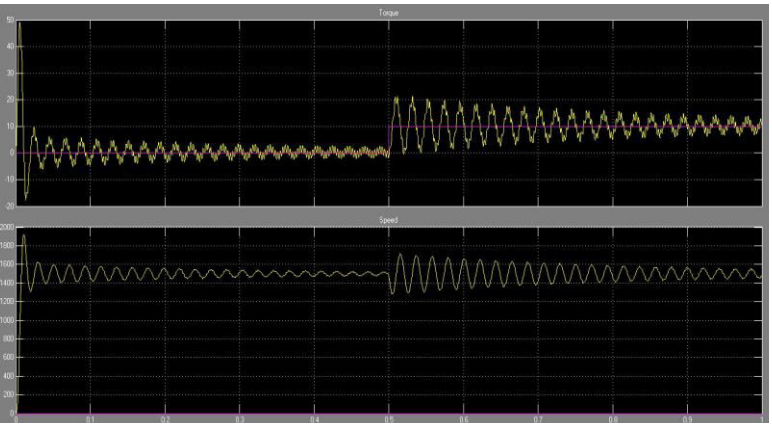
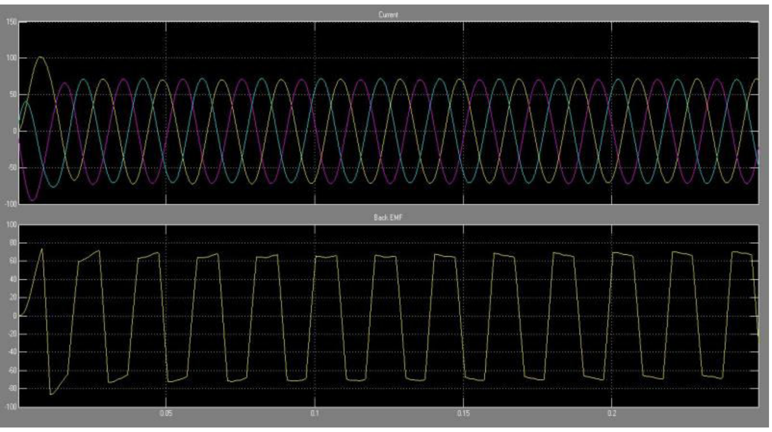


Fig.9 Torque and Speed Output of



The generated electromagnetic torque is given by,

$$T_e = [e_a i_a + e_b i_b + e_c i_c] / \omega \text{ in N-M}$$

$$T_e = K_t \{ f_a(\theta) i_a + f_b(\theta) i_b + f_c(\theta) i_c \}$$

VII. SIMULATION OUTPUT

The output of the above simulation contains Back emf, current, speed and torque of BLDC motor.

$$J(d\omega/dt) + B\omega = T_e - T_l$$

Fig.8 Current and Back EMF Output of Simulated BLDC

position is given by,

$$(d\theta/dt) = (P/2)*\omega$$

T_l =load torque

ω= Motor inertia

B =Damping Constant

P = Number of poles

ADVANTAGES OF EV

Cheaper to maintain

A battery electric vehicle (BEV) has less moving parts than a conventional car. Less servicing and no expensive systems are needed in an EV.

When the battery is dead and will eventually need to be replaced. Most car manufacturers guarantee their EV batteries for about 8 years.

The maintenance cost of the gasoline engine of a plug-in hybrid electric vehicle (PHEV) is high because it requires regular maintenance.

Health benefits

Less harmful emissions are good for our health. Better air quality and less noise will lead to less health problems caused by air pollution.

VIII. DISADVANTAGES OF EV

Charging Woes

Electric cars need charging stations, and people's long-distance travel needs such a network of charging stations with an excellent geographical location. Similarly, charging a battery typically takes about 3 hours. This cannot be compared anywhere with the efficiency of natural gas refueling. Long journeys could be a problem, but not with sensible planning.

Traveling Distance (Range)

On average, a car can travel about 100 miles on a single charge. However, the electric vehicle technology proposed by Chrysler should allow the car to travel longer. No such statement has been issued, but the fact is that most electric vehicles are more useful. Times are changing, and electric vehicle batteries are different from the past.

These bulky beasts that power cars can now last longer and help you drive faster and farther. The maximum distance for things like Tesla Model S is about 337 miles. The Chevrolet Volt has 238 miles. Both are fully electric cars. Future Tesla electric vehicle models (such as Tesla Roadster) will also develop. Distance is no longer a disadvantage of electric vehicles. Of course, its battery life and usability are not comparable to gasoline, but the technology is improving every day. The sentence is not at all true. Acceleration is not an issue in electric vehicles because it uses brushless motors, which can provide

Overloaded Batteries

Batteries are the heart of EVs. All car accessories viz. radios, car air conditioners, etc. use up electric power from batteries, and battery drain quickly. Recharging them takes time!

IX. CONCLUSION

The growth that Electric Vehicle industry has come across in past year was not wholeheartedly welcomed, however it is very important in coming years due to increase in greenhouse gases. The major hindrance to the adoption of electric transport system is related

to economy, as internal combustion engines that are readily available are less costly. In addition to this the realization of electric vehicle industry relies on global population. We can just hope that by mass marketing, environmental programs and educating people it would be possible to increase the demand of electric vehicle in the market at lower cost.

Electric Vehicles are one of the most important and key transportation systems for the future aspect. We came across the present situation of Electric Vehicle in the market, we saw the principle, construction, working and simulation in this report. The report also includes the components used to design a Electric Vehicle and the methodology followed. The application and scope of Electric Vehicle in India and other countries are also being discussed to clarify the need and acceptance of the same.

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