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ALL ELECTRIC BUS – INDIA – One of the World's most exciting EV market

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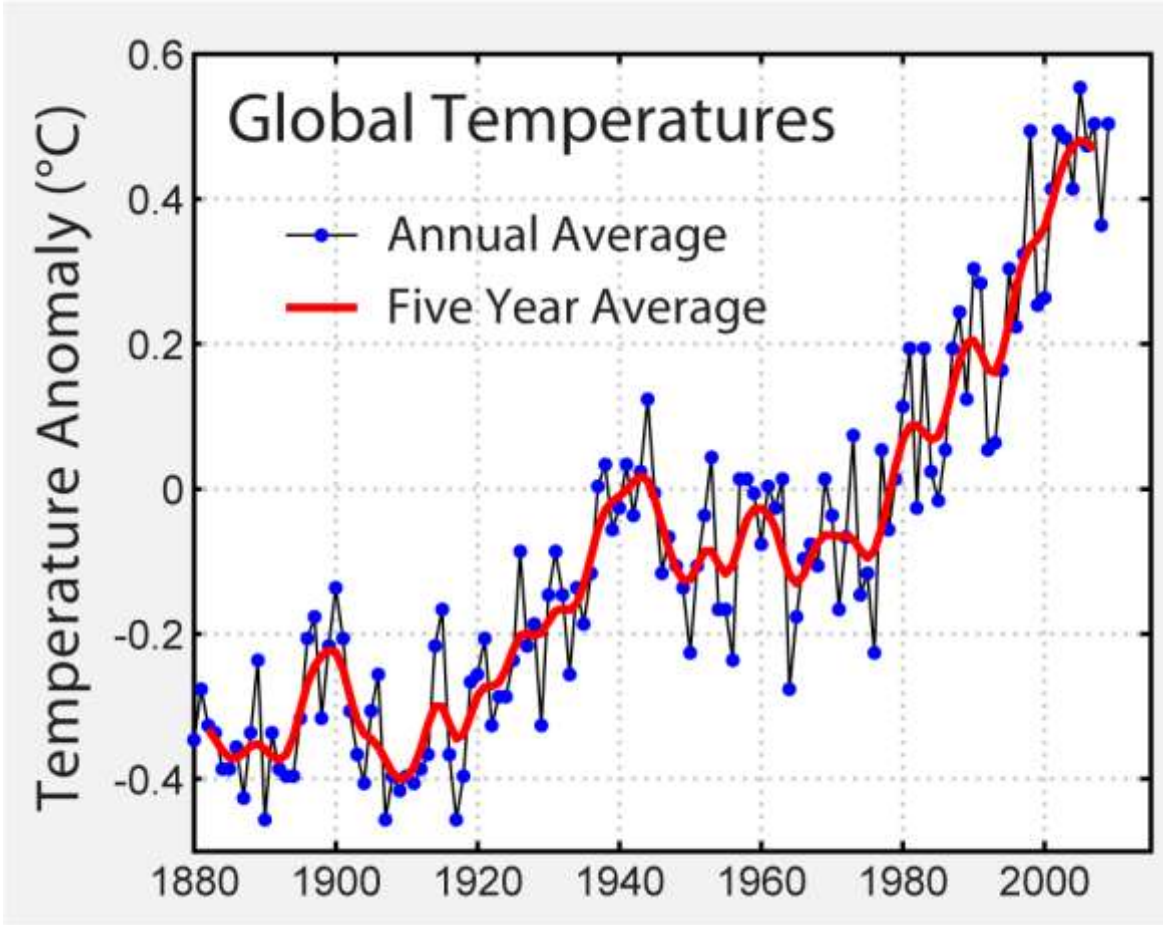

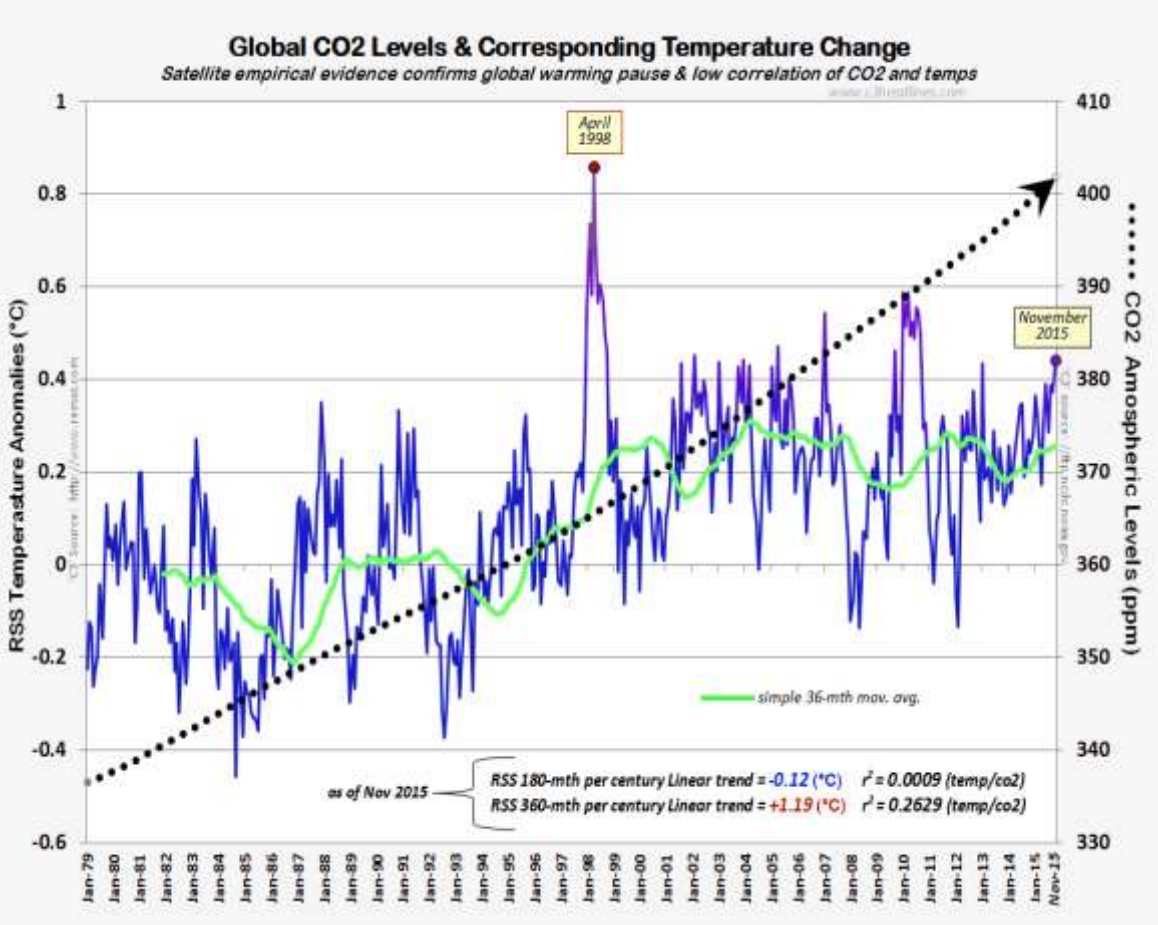

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With pollution levels going high and global warming the vehicles using fuel are being replaced with non polluting all electric vehicles.

In India also the electric vehicle movement has started, Mahindra has started manufacturing all electric car in Banglore, Honda has brought all electric two wheeler on the road. Government has imported all electric buses for parliament, in New Delhi, and in Nagpur, and Delhi, all electric three wheelers are replacing existing three wheelers on road.

In the near future the market for all electric vehicles and components in India will be huge. If one can go in to this business at this stage, when there is total vacuum, can enjoy benefits of leader.

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India’s electric vehicle (EV) sales increased 37.5 per cent to 22,000 units during FY 2015-16. Government’s vision is to see six million electric and hybrid vehicles by 2020.

Tata Motors Ltd has won a marquee government contract for supplying 10,000 electric cars, for the Rs1,120 crore order, the largest such procurement anywhere in the world.

The vehicles will be procured by state-owned Energy Efficiency Services Ltd (EESL) at a per-unit price of Rs11.2 lakh and will lay the foundation for the National Democratic Alliance government’s ambitious plan for a mass shift to electric vehicles (EVs) by 2030.

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TRANSPORT SECTOR - INDIA'S GREATEST POLLUTER

Transportation comprises 51% of pollution in India, and in urban area, 75-80%

Earth has oil sources which can last for about 40 years.

World wide the movement of Electric vehicles has started long ago and EV's are on the road in developed countries.

In India, the movement of EV has started recently, and expected to pick up the speed in near future.

Development of EV in India started by Mr. Chetan Mani. Chetan's petrol free race across Australia inspired him to work on delivering zero emission mobility solutions.

In 1994 he founded REVA to give sustainable mobility via affordable electric cars. The first Reva was rolled out in 2001 in Banglore, and 2004 in London.

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EV _ Is it the answer?

EV solves two major issues – **Climate change and Energy Security**

Lowers overall energy consumption and emission regardless of source

Much lower in noise pollution

Use available power sources

Initial cost is high however, profitable in long run.

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Barriers to Electric Vehicles.

- Higher cost of EV, every individual cannot afford the high cost of EV. The target in first phase is to convert mass transport system to EV
- Challenges in Battery technology, Battery cost is very high as well battery charging time is considerably high. Fast charging batteries are comparatively costly. Government is giving cash subsidiary of about RS 10,000 per KW on Li-FE batteries to bring down the cost.
- Limited range of EV, Battery required to give considerable range add on weight to vehicle, also the battery cost is directly proportional to battery capacity.
- Lack of infrastructure, Charging infrastructure not yet developed. Soon all HP and BP petrol stations will have charging stations. Also the battery swapping options are available.
- Consumer mindset,
- In-adequate government support, now recently government has declared support in many areas and policies are framed to push the EV in mass transport segment and on passenger vehicle segment also. (FAME II, higher depreciation, income tax rebate and cash incentives to promote EV)

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Steps to over come the multi dimensional challenge –

- Government, Public, Private support to promote EV,
- Special focus on taxi, Commercial vehicles, Buses, etc.
- EV conversion/manufacturing,
- Leveraging technology to give seamless EV running experience with optimized power grid.

National subsidies for Ev's

Reduced excise duty of 7%

Reduced vat to 5%

Ministry of new and renewable energy subsidy,

80% depreciation in 1st year.

Most of the states in India does not charge any road tax for EV's.

Tax benefit of RS 150,000 for passenger cars.

Private Co initiative – Sap India pays staff for green commute. EV buyers to get car allowance, Free battery charging, Dedicated parking slot, Charging point at owner's residence, service on campus etc.

Society of Manufacturers of EV

Common platform for EV manufacturer and key stake holders was formed in 2008, with Key objectives as –

- Take the Indian EV industry to new heights,
- Authentic industry data for the policy makers,
- Certification and regulatory bodies to evolve appropriate safety and engineering standards.
- Best practice sharing,
- Develop relationship with future customers or Suppliers.

Currently there are two manufacturer for EV 4W business, where as about 20 manufacturers for 2 wheeler EV, and about 12 manufacturer for EV components.

Only two manufacturers are catering for EV motors, one for simulator, 4 for battery manufacturing, and 1 for Certification and testing.

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In order to promote the EV government has formed National mission for electric mobility. (NCEM)

Leveraging Technology in future for seamless EV running experience offers –

- Solar cell stickers on EVs for charging batteries, Hybrid-Electric + Solar chargers – Envision Solar international inc. –Clean Charge, a solar-powered EV charging station.
- Ultra fast charging station for LI-FE batteries.
- Existing oil net work for Battery replacement & charging.
- Towable range extenders (PRU) available from EMAV, Indiana.
- Wireless charging, even during the running vehicles, (yet to come in India, working in part of Europe)
- Grid Optimization –Communication between EV and the power grid, charging based on the grid condition and the vehicle's battery state, effectively manages charging during peak hours.
- Government has recently announced a plan of preparing the road suitable for charging EV during running, similar to the one operational in Switzerland.

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WHY ELECTRIC VEHICLE?

The Indian auto industry is one of the largest in the world which accounts for 7.1% of the country's Gross Domestic Product (GDP). Production of passenger vehicles, commercial vehicles, three wheelers and two wheelers grew at 5.41% in FY17 to 25 million vehicles from 24 million vehicles in FY16.

Exhaustion of fossil fuels, environmental concerns and increase in energy costs is compelling India to shift to electric mobility. E-mobility is the future and the most potential solution.

Committing to the Paris Agreement, India has announced a major transformation to electric vehicles by 2030. The Government has also initiated Faster Adoption and Manufacturing of Hybrid and Electric vehicles (FAME) scheme which provides incentives for purchasing electric vehicles.

National Electric Mobility Mission Plan (NEMMP) 2020' which was formed in 2013 addresses issues of National energy security, vehicular pollution and growth of domestic manufacturing capabilities.

Government's vision is to see six million electric and hybrid vehicles by 2020.

Unlike vehicles with ICE, electric vehicles do not produce exhaust gases during operation. This alone makes electric vehicles more environmentally friendly than vehicles with conventional technology.

Here we will discuss about the vehicle driven by electric motor powered by re-chargeable batteries.

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The History of Electromobility

Electromobility has always been an issue that has helped drive the development of vehicles. It did become less important for a while because the oil fields did not appear to be drying up, but now electromobility is becoming increasingly significant as people became aware of the depletion of oil reserves and the need for global environmental and climate protection.

For India it is of very high importance as India is second largest importer of oils, and a huge amount of foreign reserve is used for importation of oils.

In the year of 1821 Thomas Davenport builds the first electric car with non-rechargeable battery and a range of 15 to 30 km.

In the year 1860 the rechargeable lead –acid battery was invented.

In the year 1881 the first officially recognized electric vehicle is a tricycle made in Paris, using a rechargeable lead-acid battery. The vehicle achieved the speed of 12 KMPH.

In the year 1900 Ferdinand Porsche presents a vehicle with in-wheel motors on both wheels of the front axle at the world exhibition in Paris

In the year 1985 the world's first race for solar powered cars, the "Tour de Sol" is staged in Switzerland.

The History of Electromobility

PSA Peugeot Citroen builds 10,000 electric vehicles from 1995 to 2005.

In the year 2008 The exclusively electric powered “Tesla Roadster” built by Tesla Motors is launched in US market with 6187 laptop batteries connected in series. It accelerates from 0 to 100 kmph in 3.8 sec.

In the year 2009 the German government introduces the national electromobility development plan, the goal is to promote the research and development, the market preparation and the launch of battery powered vehicles in Germany.

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E- mobility and its impact-India

Environment –

- Climate change
- Reduction of global CO 2

Emissions

- Reduction of Noise emission
- Awareness of consumption

Of raw materials.

Technology –

- Technical advantage of electric

Motor compared with IC engine.

- Increase in efficiency
- High voltage safety

Society -

Growing mobility

Increasing urbanization

Increasing acceptance

Increasing demand

Economy –

Limited Oil reserve

Rising prices for fossil fuels

Desire for independence from oil exporting countries

Infrastructure -

Comprehensive infrastructure to supply energy for EV

Policies --

International specifications for emission limits.

Development plans and subsidies.

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ADVANTAGES OF ELECTRO MOBILITY

- Electric drive motors run quitter than IC Engines. The noise emission from EV is very low.
- EV produce no harmful emission or green house gases while driving. If battery is charged from renewable energy sources, an EV can be run CO_2 free.
- EV motors is very robust requires little maintenance.
- Electric motors have a high efficiency of up to 96% compared with IC Engines that have an efficiency of 35-40%
- Electric drive motors have an excellent torque and output characteristics. They develop maximum torque from standstill. This allows an electric vehicle to accelerate considerably faster than a vehicle with ICE producing the same output.
- The drive train design is simpler because vehicle components like transmission, clutch , starter, alternator, spark plug are not required.
- The electric drive have the regenerative capabilities, that means the batteries can be charged during braking.
- The energy is only supplied when the user need it. Compared with conventional vehicles the electric drive motor never runs when the vehicle stops at red light. The electric drive motor is highly efficient particularly in traffic jams and bumper to bumper traffic.
- Electric drive minimizes the no of moving components compared to ICE and thus the maintenance requirements are drastically low.

DISADVANTAGES OF ELECTRIC VEHICLES

- Electric vehicles have limited range due to the battery size and construction.
- Charging high voltage battery can take a long time, depending upon the battery charge and power source.
- The network of electric charging station is yet to be develop in India.
- If the destination is beyond the range of electric vehicle, there might be necessity to carry range extender or have the battery charging facility on the way.

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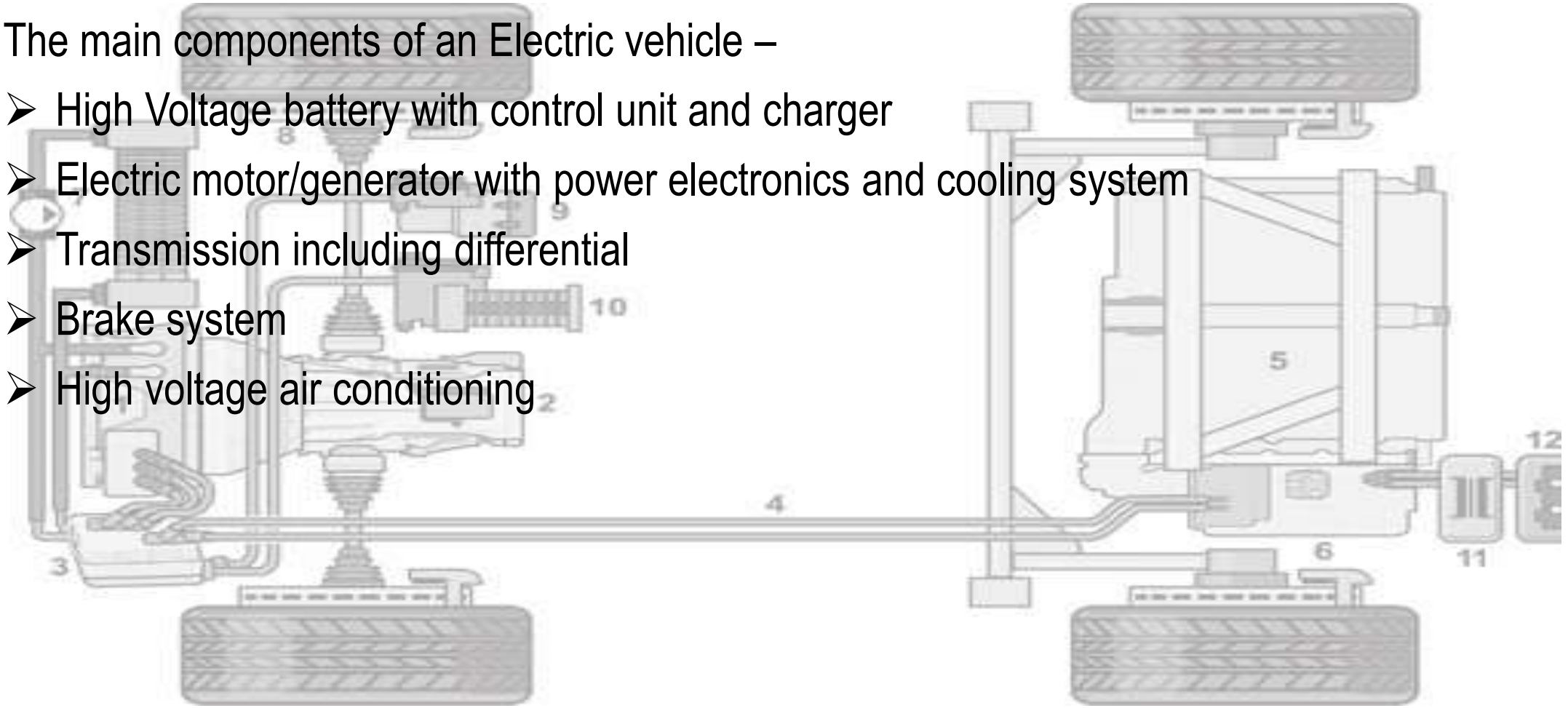
BASICS OF E-MOBILITY

The main components of an Electric vehicle –

- High Voltage battery with control unit and charger
- Electric motor/generator with power electronics and cooling system
- Transmission including differential
- Brake system
- High voltage air conditioning



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1. Electric motor/generator
2. Transmission with differential,
3. Power electronics,
4. High voltage lines,
5. High voltage battery,
6. Electronic control unit for battery
7. Cooling system
8. Brake system,
9. High voltage AC compressor
10. High voltage heating,
11. Battery charger
12. External charger contact
13. External charging source

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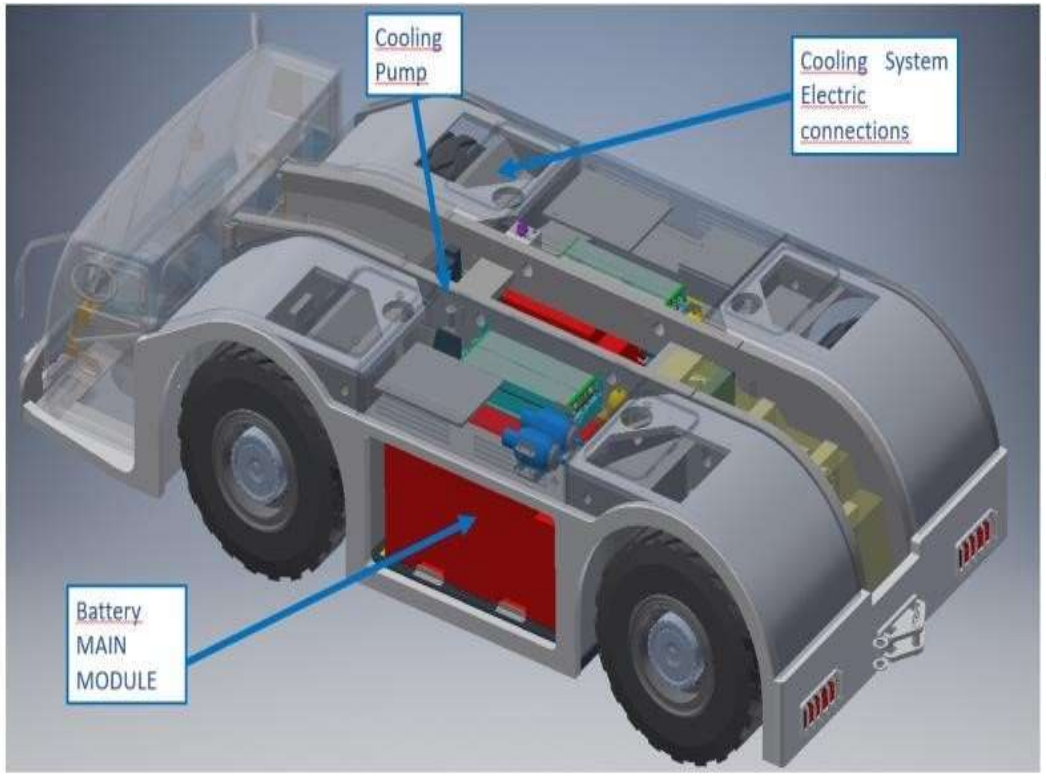
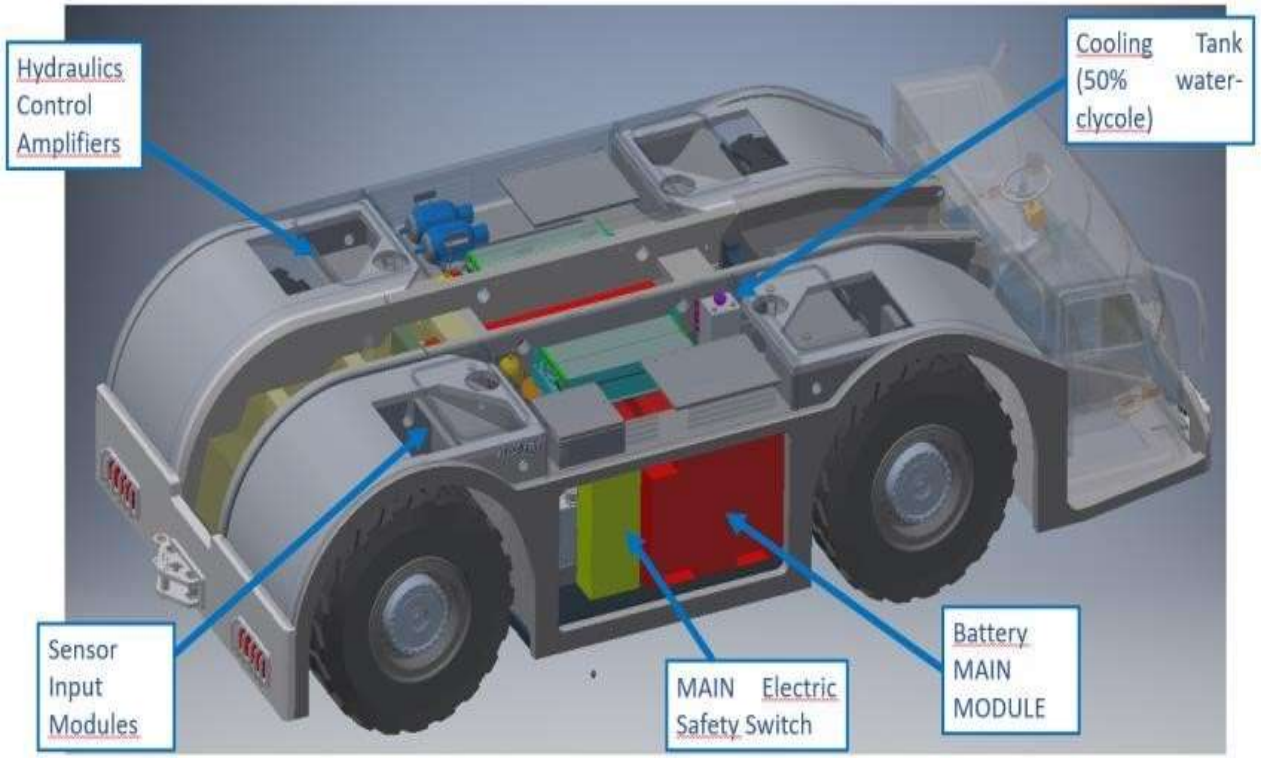
Placement of component in a typical arrangement for EV kit retrofitting





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WHY RETROFITTING ELECTRIC KIT?

As per the government directives the BS IV emission standard vehicles manufacturing and sales will stop from April 2020.

In due coarse BS IV emission standard and older vehicles will be removed from road.

The amount of such vehicles is very high, and all of a sudden if these vehicles are removed from system, they will not be replaced with new vehicles immediately. This may create a shortage of vehicles on road.

Secondly the investment required for replacement is very high, and all transport operators may not afford such investment.

Retrofitting the electric kit is a best solution, As the old vehicles can get new life and can be brought back on road by replacing the IC Engine, Gear box, and transmission. By retrofitting we can create an asset out of old vehicle, which probably has no value.

Retrofitting helps in Cost savings, implementation of re-use concept, best option for individuals, & Reduced load on recycling, Faster roll out,

- Reduce – Use of oil & Emissions –Braking loss, transmission loss, Engine loss, Standby/idle loss.
- Reuse – Existing vehicle, pocket friendly, minimize the resources consumption
- Recycle – Used components from old automobiles

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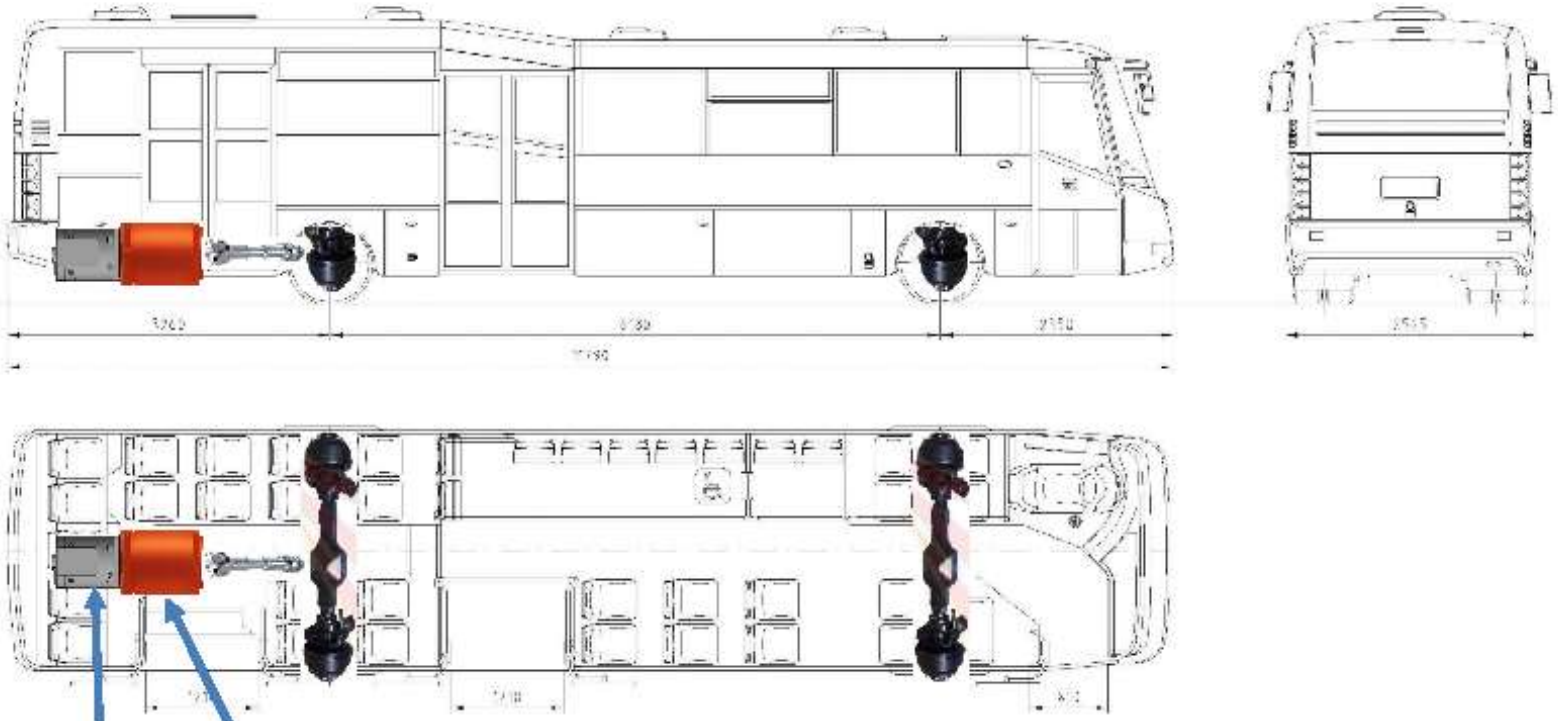
City BUS architecture (with 3 speed gearbox)

(Suitable for max speed of 105 kmh)



The schematics of the main components is scaled to size.
Battery/SuperCAP will be sized depending on further info regarding cycles and actual bus design in details. Will probably be splitted into multiple packs connected in series.

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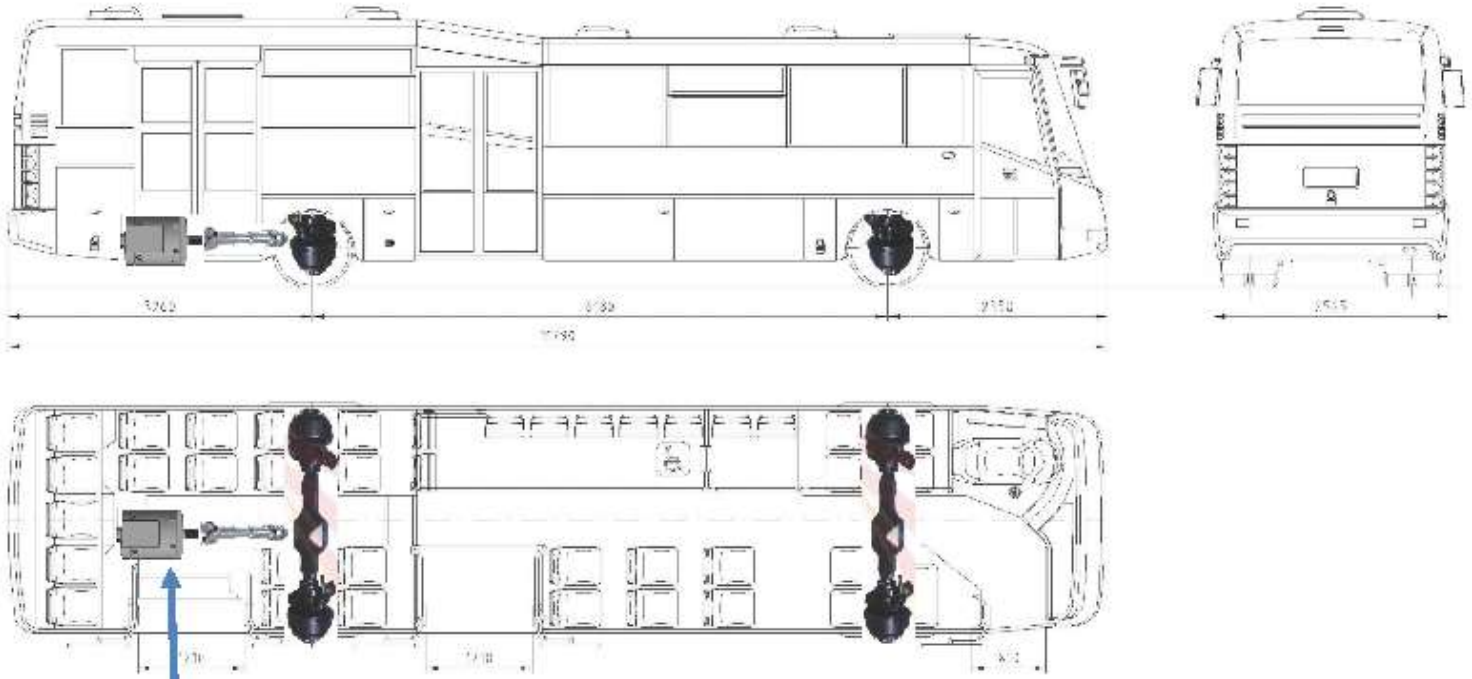
City BUS architecture (Direct DRIVE)

(Suitable for max speed of 65 kmh)



280 kW
e-MOTOR

The schematics of the main components is scaled to size.
Battery/SuperCAP will be sized depending on further info regarding cycles and actual bus design in details. Will probably be splitted into multiple packs connected in series.

The high efficiency, high torque electric motor/generator –

As specified by the name, the electric motors used as drive system are having very high efficiency (about 96%) and very high torque. Since during the operation these motors are generating heat, these motors are equipped with fluid cooling system to keep the motor cool.

Hybrid and electric vehicle technology has seen rapid development in recent years. The motor and generator are at the heart of the vehicle drive and energy system and often utilise expensive rare-earth permanent magnet material.

Existing hybrid and electric vehicles, such as Toyota Prius, Chevrolet Bolt, Nissan Leaf, and BMW i3 all use high-energy-density permanent magnet (PM) machines for electric propulsion. The magnetic material is usually sintered neodymium–iron–boron (NdFeB).

Squirrel cage induction motors (IM) have been successfully used in electric vehicles (GM and Tesla) and commercial vehicles (buses and trains). They are much cheaper and more robust although they can struggle to get the same torque density.

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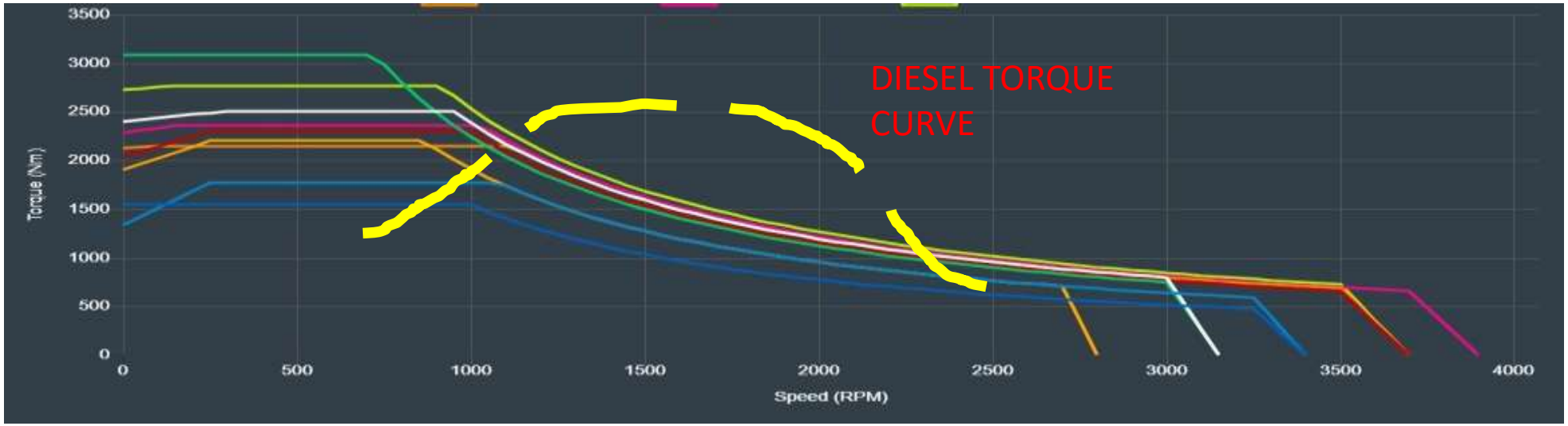
E-MOTOR ADVANTAGE

Electric brushless motors have the great advantage of delivering high torque at low speeds. This allows for simpler types of gear box, much higher efficiency, elimination of clutches or torque converters. They also allow for super precise control and brake generation, meaning that the life span of the brake can easily double compared to Diesel traction.



35 KMPH, Gear 1

65 KMPH, Gear 2

95 KMPH, Gear 3

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Types of rechargeable Battery –

The different types of rechargeable batteries are distinguished by the materials used for the electrons and electrolytes. The most common batteries are Lead-acid, Nickel-cadmium, nickel-metal hybrid & lithium-ion batteries.

Lithium-Ion batteries are commonly used in EV's. This battery uses lithium metal oxides and graphite for electrodes. These batteries contains very small amount of water and do not have a memory effect. Compared with Nickel-cadmium batteries, they have more than twice as much energy density. This means that this battery requires less space in EV leaving more room for the occupants and the luggage compartment.

Lithium Polymer batteries (LIPO), is further improvement of battery technology. These batteries are more secure, very flexible and can be adapted to fit many spaces. These are also less expensive compared to Li-io, they also have a shorter life compared to Lithium-ion batteries.

Li-Po cells are available in flexible pouch form, which are packed together as per requirement and connected to make a battery. Higher the capacity requirement, higher no of cells are required. Li-Po batteries have fast charging capabilities.

Battery management system -

BMS is specially designed for rechargeable lithium battery packs to enhance efficiency and performance of complete solution.

This communicative BMS monitors all cells current and voltage fluctuations in pack and temperature of pack. Display of all parameters prompts to take required actions timely.

A battery control system is used for managing remaining battery voltage and control of battery charging. The voltages of the individual cells are monitored and the balance controlled by a battery cell monitor MCU and lithium-ion battery cell monitor ICs. Battery management MCUs can perform management of remaining battery voltage and battery charge control. BMS is completely electronic system.

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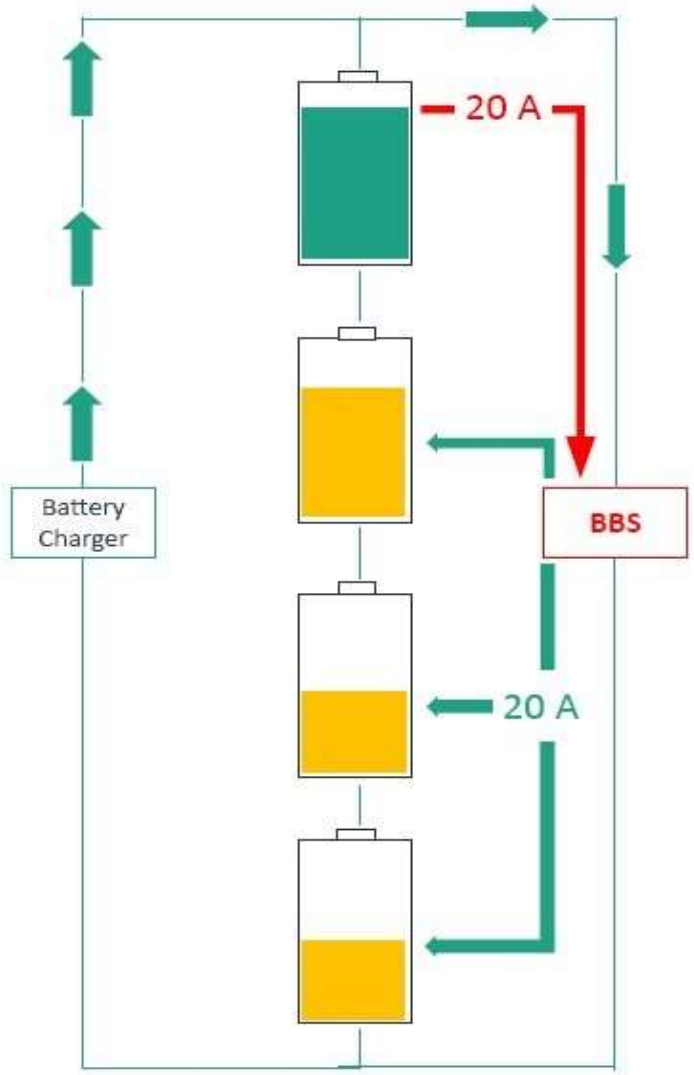
HIGH VOLTAGE MULTICEL BATTERY



Battery Balancing System

BMS New generation

The Battery Balancing System (BBS) distinguishes itself mainly for its **combined balance**:

- **ACTIVE** and **PASSIVE** Balancing
- **HIGH POWER** BALANCE

BBS

The BBS electronics can handle over **20 A** of balancing current.

During charging phase, the system can pick up 20 A from the "maximum" cells and support the "lowest" with just the same current.

In a multicell high voltage battery pack the most critical aspect is managing the state of charge of all single cells. When a single cell dies the battery might be forced to stop.

Using the most advanced and powerful Battery Balancing System in the industrial heavy duty battery market , customized battery packages for batteries suitable for vehicles up to 900 kw peak power and 800 V level, are provided.

Battery Balancing system is very important electronic control system to maintain the battery in healthy condition for a longer periods. BBS plays very important role during battery charging and usage both.

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HIGH VOLTAGE MULTICEL BATTERY

FAST CHARGE at every opportunity

- **+ 50%** CHARGE IN **just 30 minutes**
- **Complete charge** in **2 hours**
- Accept **partial** charge and discharge
- **No charging room** required
- **No** memory effect

$LiFePO_4$ (LFP)

LFP cells are characterized by the safest chemistry available on the market due to the thermal and chemical stability of the bond Iron - Phosphorus - Oxygen. Best Life Relationship - Safety - Performance

$LiNi_{1/3}Mn_{1/3}Co_{1/3}O_2$ (NMC)

They are only used in special applications that require high power. The low capacities of individual cells and formats available today on the market do not make them suitable for industrial use.

$LiCoO_2$ (LCO)

Technology characterized by high density but with long charging times and short life expectancy. It may be dangerous if damaged due to the Co-O (Cobalt-Oxygen) bond.

$LiNi_{0.8}Co_{0.15}Al_{0.05}O_2$ (NCA)

Energy density improved. The low capacities of individual cells and formats available today on the market do not make them suitable for industrial use.

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VEHICLE CONTROL PLATFORM

This is highly customizable vehicle control platform based on codesys IDE, that can be quickly adapted and configured for any industrial vehicle both Electric drive and Diesel drive.

It includes controls and diagnostics over prime mover, all hydraulics, electrical traction control and any other major machine service.

It provides GSM/3G/4G data telematics from remote diagnostics and local WIFI access for easy fleet management.

Based on multi bus architecture (Ethercat, etc) it can easily integrate any specific sub-apparatus such as laser guidance, anti-collision detectors or other special integration.

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HOW DO WE INTENT TO DO THE RETROFITTING OF ELECTRIC KIT

Given here below the steps we intent to take for creating a value (asset) out of your old vehicle.

1. The body will be reworked/repaired as per requirement.
2. Engine, gear box and transmission will be removed from the vehicle.
3. Chassis will be inspected and required steps will be taken to ensure the extended life of about 10 years.
4. Electrical kit, battery, control system and charging system will be installed on the vehicles.
5. Once ready the vehicle will be tested for the quality checks and quality assurance.
6. One no of kit duly installed on the vehicle need to submit for approved from ARAI.
7. The vehicle will be test run on the road for 3 months in our close supervision for performance.
8. Once proven satisfactory the commercial lot of say 100 vehicles will be taken for retrofitting e kit.

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Why one should go in this business –

1) EV is need of the day and taking fast space changes world wide. World leaders like USA, France, Germany, Italy are having EV's running on road for long time, the technology is matured, proven and tested.
2) India has witnessed the change. A lot of two wheeler and three wheeler are EV, few passenger cars are also EV. Transport in parliament is EV.
3) Government is committed to reduce green house gases generation, and promote clean and green technology.
4) Government plan is to have 600,000 EV's on road by 2020.
5) First commercial order of 10,000 vehicles is being delivered by end of this year by Tata motors. Mahindra also has bagged government orders.
6) All major manufacturers have plans to manufacture EV's in India and are gearing up to roll out EV's in couple of years.

In short there is a big demand in near future and one can enjoy the benefits of leader.

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OUR PROFILE.

We are basically a Mechanical engineer, backed up with post graduation in marketing and production management.

Having wide experience of over 42 years in Industry, (includes 20 years overseas exposure) locally as well in International market.

Mr. Nandkishor Sarolkar was a nominated member of Kenya Bureau of standards.

Last assignment in India – Managing Director cum CEO of M/S Bericap India Pvt Ltd. A group company of MNC, having head quarter at Germany, involved in the business of Plastic caps & closures .

We have successfully implemented over 24 projects on turn key basis in India, Kenya, Tanzania, Nigeria, South Africa, Kuwait, etc.

Mr. Sarolkar is owner of 8 no. Design registration (intellectual property) for the innovative quick connector mainly used for Air and Water application.

Mr. Sarolkar has successfully executed a strategic alliance and Technology transfer for Pune based company with European established Solar Panel manufacturer to make the European quality Solar modules in Pune, India.

We are also working on Retrofitting EV kit on 9 meter city bus with European partner.

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Pl. feel free to contact us should you require any additional information.

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