IN CHARGE WITH ELECTRIC VEHICLES

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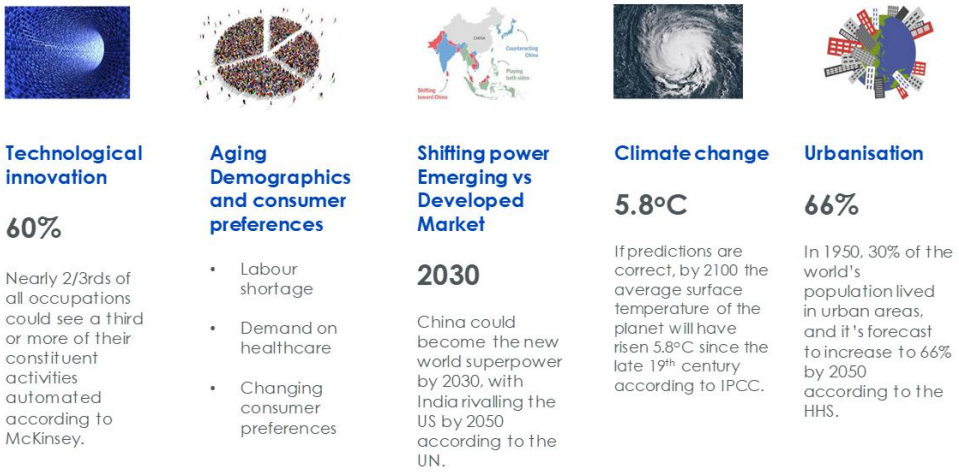
Electric Vehicles (EVs) tap into key megatrends

The world is changing at a rapid pace. Over the next decade, we expect five key megatrends to shape the framework in which we live. The marriage of two of these key megatrends – (1) technological innovation and (2) climate change builds the case for EV adoption. The reason for this is, the rise of EVs plugs the problem of rising global carbon emissions along with reaping the benefits of the rapid technological advancement.



Sources: Mc Kinsey July 2016, United Nations (UN) June 2017, Intergovernmental Panel on Climate Change (IPCC) May 2018, US Department of Health and Human Services (HHS) May 2014 and WisdomTree

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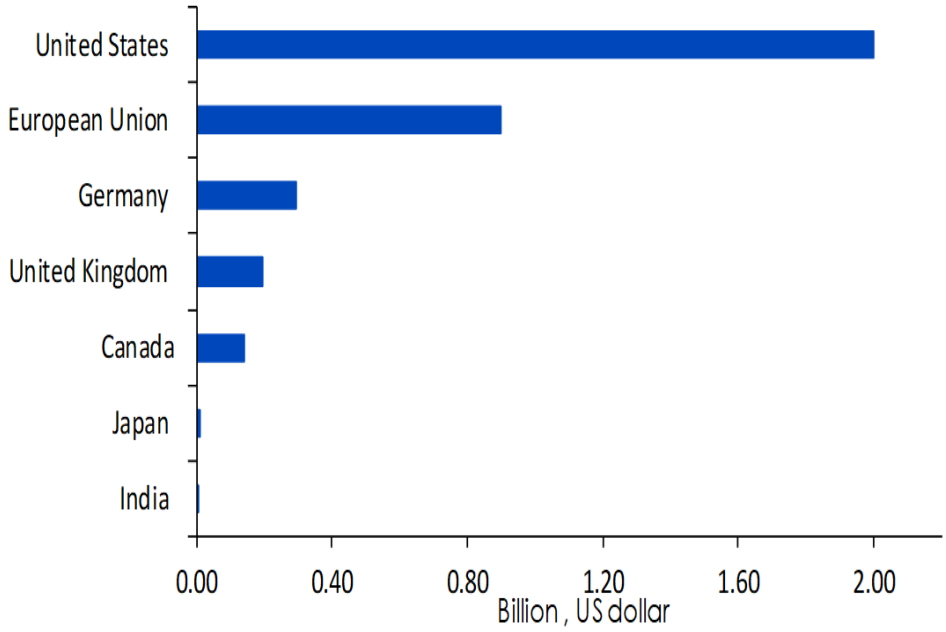
Impact of Policy Change

Political will has been the cornerstone of the shift to electrification. More than nine countries and a dozen cities or states have announced bans on the internal combustion engine within the next decade or so. Governments across the globe are supporting the shift to electrification in the auto industry by providing the necessary infrastructure and tax incentives. In doing so, they are signalling the urgency to move to zero emission vehicles to meet their climate and air quality goals. Recent investment announcements for EV infrastructure development in selected countries (Billions USD) are highlighted below:



Source: International Energy Agency, WisdomTree, data available as of close 28 June 2018

China is going green

China is spearheading its way in the EV market and accounted for nearly three quarters of global EV sales in 2017. China is yet to set a deadline for automakers to end sales of gas and diesel engines. However, the government has set very specific and trackable targets on environmental development in its 13th five-year plan. China is positioning itself to be a leader of New Energy Vehicles (NEVs) in terms of both shipment volume and technology.

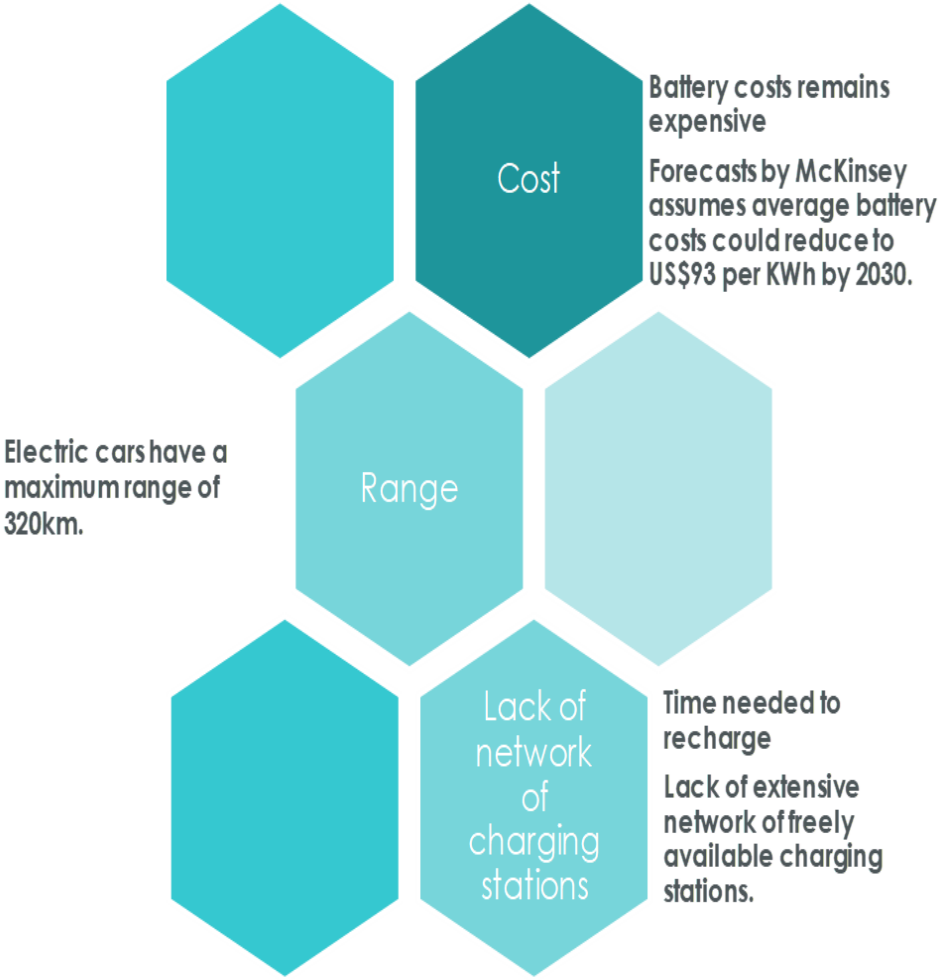
After four decades of growth China's environmental quality is now significantly poor. The government is intent on raising environmental standards. In 2015, a central government led crackdown on pollution was first introduced in the 13th five-year plan. Thousands of industrial plant owners were fined and charged for misconduct. Despite the marginal improvement in air quality it is still far from reaching the healthy standards set by international organisations. Most of China's pollution is a result of heavy coal use which accounted for 60.4% of its total energy consumption in 2017. We are now likely to see an increase in consumption of natural gas and non-fossil fuel sources owing to the governments binding targets on energy and carbon intensity.

China has become the world's largest auto market since 2009. Road networks contribute to 76.8% of its freight traffic and is the largest source of air pollution, underpinning the significance of the shift to New Energy Vehicles (NEVs) in China. Both the consumer and manufacturers are benefiting from government subsidies on New Energy Vehicles. In August 2017 the government issued its "Beijing -Tianjin-Hebei Autumn and Winter Air pollution control plan 2017-18". The state council further announced a 3-year action plan for Winning the Blue Sky Defence War, with detailed targets and measures in June 2018. The Chinese government aims to sell 2mn NEV in 2020 & 7mn NEVs by 2025.

Hurdles in the EV industry

The cumulative number of plug-in electric vehicles sold worldwide, for the first nine months of this year, stands at 1,279,000 (up 68% year-over-year) marking 1.8% market

share. Pure Battery Electric Vehicles (BEV) led the pack up 61% and Hybrid Electric Vehicles (HEV) rose 36% over the prior year. Projections on the EV market remain optimistic. The International Energy Agency (IEA) expects EVs to become mass market in the next 10- 15 years. The following three hurdles appear to be holding back mass EV adoption.



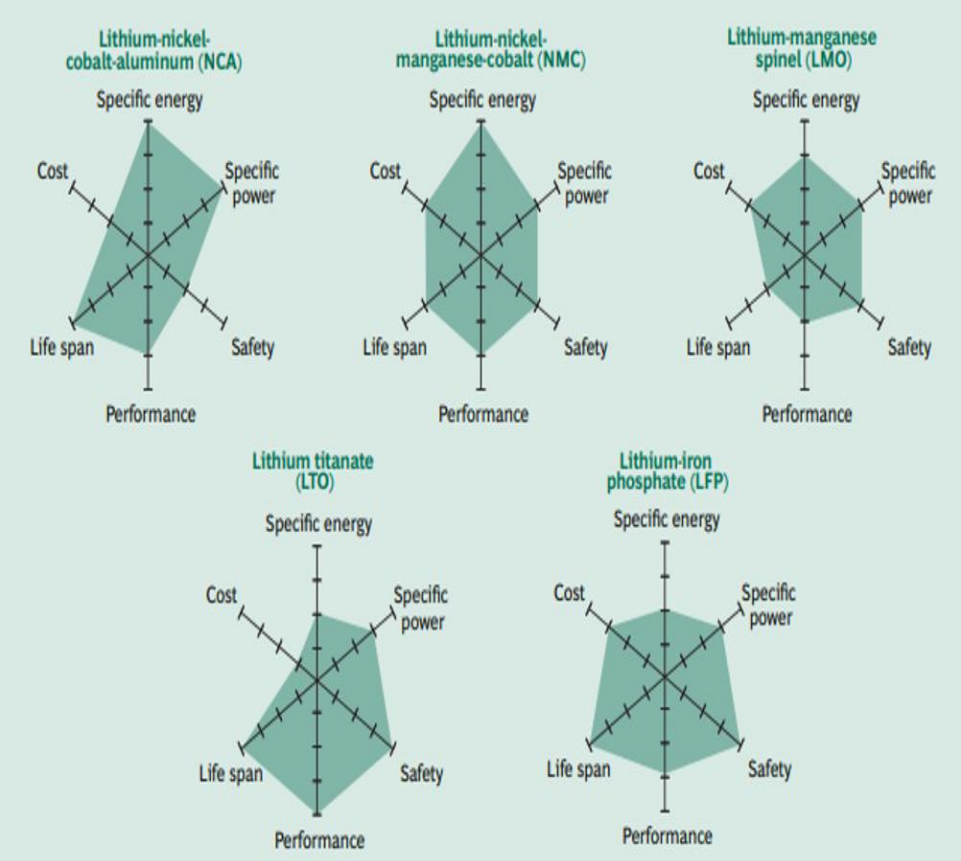
Source: WisdomTree

Higher battery costs are one of the main obstacles holding back consumers from buying EVs. Innovation in battery technology have enabled battery costs to decline from US$1000 per kWh (Kilo watt hour) in 2010 to below US$250 per kWh, according to S&P Global Platts. Battery prices are expected to decline further by US$100 by 2030, at which point EVs are likely to be competitive with Internal Combustion Engine (ICE) vehicles.

Advancement in battery technology

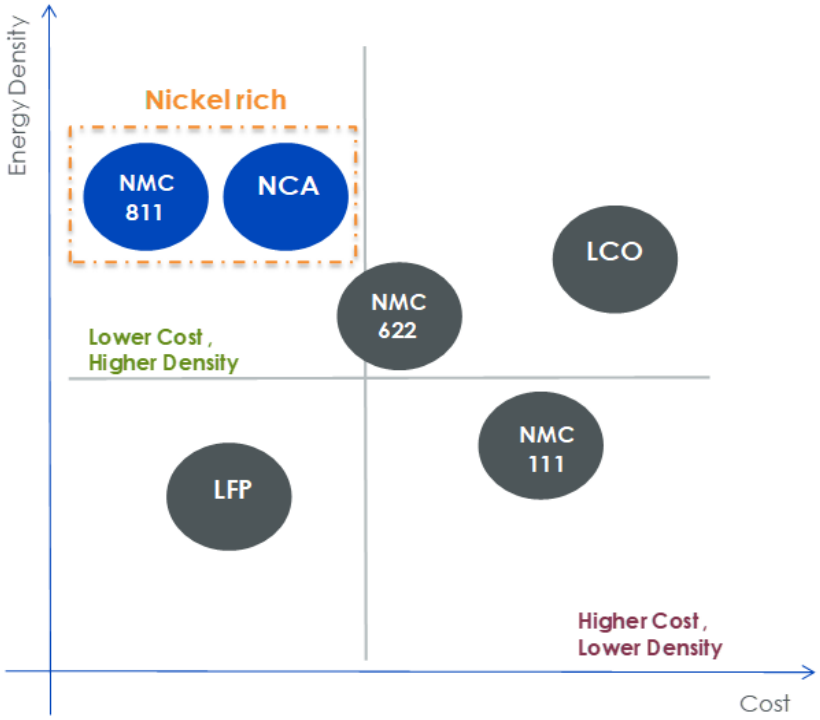
Lithium-ion batteries (LiBs) are the most widely used batteries in EVs owing to their high energy density. Metals account for 40% of the costs of LiBs according to consultant firm Roskill. These batteries require more than just lithium, with other metals used in the electrodes (anode and cathode) including graphite, cobalt, nickel and manganese. LiBs adopt a range of battery chemistries that employ various combinations of anode and cathode materials. The five most advanced technologies used in LiB are: Lithium Manganese Oxide (LMO), Lithium Cobalt Oxide (LCO), Nickel Cobalt Aluminium (NCA), Nickel

Manganese Cobalt (NMC) and Lithium Iron Phosphate (LFP).



Source: Boston Consulting Group (BCG), January 2010

Each of the above Lithium ion technologies can be compared along six dimensions: safety, lifespan (measured in terms of both number of charge and discharge cycles and overall battery age); performance; specific energy (how much energy a battery can store per kilogram of weight); specific power (how much power the battery can store per kilogram of mass) and finally cost. Safety is by far the most important criterion for LiB. Meanwhile battery producers face a constant tug of war between cost and safety as no single technology delivers on all six dimensions.



Source: WisdomTree

While the NCA boasts of high performance it poses safety challenges, the LFP ranks high on safety it has lower specific energy. While battery technology has taken great strides, there is no single technology that ranks highly on all six dimensions. Battery technology remains in a constant struggle to find the right chemistry to achieve the optimum performance across all six dimensions.

At present, the NMC battery that contains equal parts of nickel, cobalt and manganese (in a ratio of 1:1:1) has gained widespread acceptance among manufactures. Battery manufacturers are experimenting with the composition ratios of these metals and are favouring a higher proportion of nickel. Implementing a higher proportion of nickel provides the benefit of higher energy in the batteries over long distances and also make the batteries lighter. However, the lifetime of these batteries is short. Added to that, higher nickel ratios reduce battery manufacturers dependence on cobalt. Most of the world's supply of cobalt arises from the Democratic Republic of Congo. Owing to the country's political instability combined with human rights spotlight on child labour, a large portion of the world's supply of cobalt remains at risk. According to Roskill and Benchmark Mineral Intelligence (BMI), NMC batteries featuring higher nickel proportions of 5:2:3 and 6:2:2 are already in use and manufactures are pushing to commercialise the NMC 8:1:1. However the NMC's 8:1:1 highly stringent requirement in terms of dust, moisture and contamination control are holding back efforts to make the battery commercial. NMC 8:1:1 is expected to gain significant market share in the EV market by 2020.

We expect the rapid pace of innovation in battery technology to speed up mass adoption of EVs. As adoption of EVs garner momentum they will have far reaching implications for commodities. We expect metals such as – nickel, copper, silver and smaller elements such as – cobalt and lithium to benefit from the uptake of EVs, which we will discuss in detail in the second part of our blog.

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