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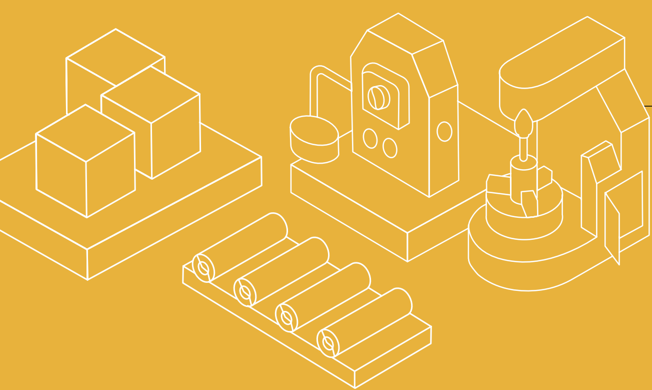


Impact on the auto component industry

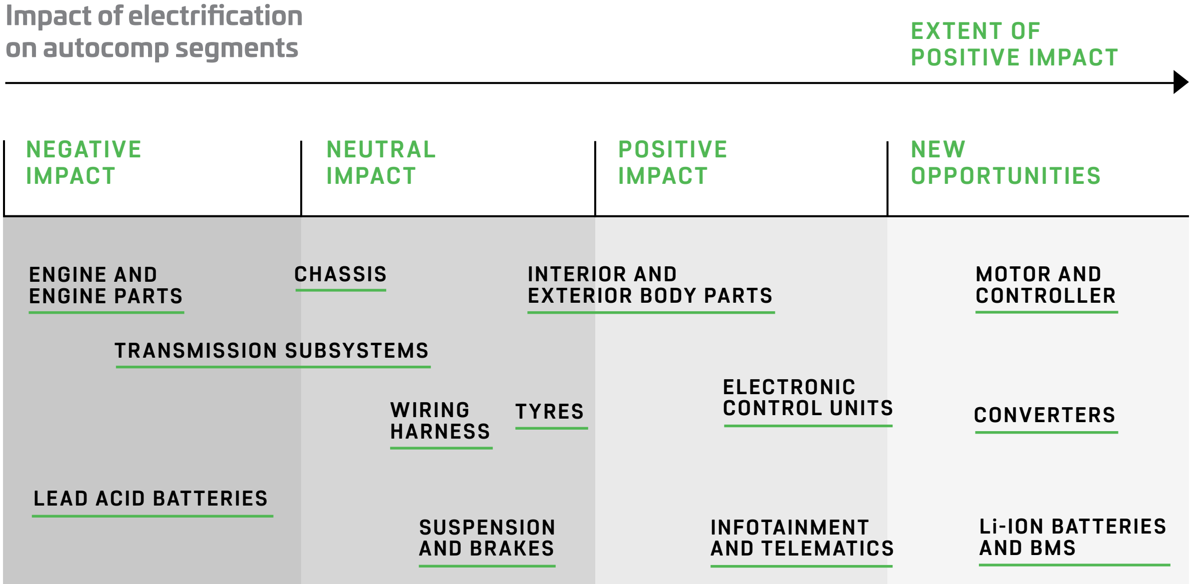
Over the years, India has successfully developed a thriving auto component industry. Today, this industry is about USD 50 billion in size and contributes to 2.3% of the country's GDP. Close to 3 million people are employed by this industry. It is also one of the most cost-efficient industries that has enabled the rapid growth of the automobile sector in India.

Electric vehicles will change the structure of the auto component industry. Many components used in ICE vehicles will disappear from EVs. The most impacted category would be engine and related components as it will be completely phased out with EV adoption. Drivetrain components would get impacted next as content/vehicle would drastically come down (except for steering related components) considering a much simpler drivetrain design in EVs. Batteries would completely change and as mentioned earlier, this is an open field for new players. Suspensions and braking systems would face a neutral impact, while mechanical designs and technologies might change/improve overall. From the component manufacturers point of view, the impact would be neutral.

Body parts, both internal and external, are also expected to remain neutral. Impact on electrical components would be neutral to negative as the electrical design of an EV would be vastly different when compared to an ICE and would therefore need a considerable shift in technology. Electronic components would have a positive impact as an electric vehicle will need sophisticated control solutions for motors and battery. Also, the larger adoption of infotainment and telematics would result in increased content/ vehicle.

EVs open a huge opportunity for certain new components. The three key components are battery, motor and controller. Today, India has little infrastructure or technology for manufacturing these domestically. These three component categories present a market opportunity of INR 150 bn by FY25. Other new components that EVs would bring into the picture are AC-DC/DC-DC converters, inverters, and e-axles.

EXHIBIT 56
Impact of electrification on autocomp segments



Grid composition and capability

1 / GRID COMPOSITION

EVs are better than ICEs, even with the current coal-heavy grid mix

India has a coal heavy grid mix. 75% of the electricity in India comes from coal and only 16% comes from renewable energy sources. Coal based electricity has a very high carbon footprint. Thus, a question that is often raised is – Is the source of pollution being shifted from cities to power plants? Li-ion batteries have a higher carbon footprint as well, through their life cycle.

So, the other important question is – Do electric vehicles have a negative carbon footprint impact over their complete life cycle?

Firstly, it is important to understand the carbon emissions of an EV vs an ICE vehicle. The data used is from the Alternative Energy Data Center of the US Department of Energy. It provides state wise car emissions average for EVs and ICE cars. Each state has a different grid mix. A regression analysis was done and the USA state wise grid mix vs EV emissions data was used to arrive at a typical EV emission for an India equivalent grid mix. An average gasoline car in the USA emits around 5.2 MT/year of CO_2. An electric car with an India equivalent grid mix emits around 3.8 MT/year of CO_2.

To draw parallels for the Indian market based on the USA data has fallacies. Indian ICE vehicles are likely to have higher emissions considering the poor road and traffic conditions. At the same time, Indian power plants are likely to have far higher emissions than similar plants in the USA. Given the difficulty in quantifying these differences, they have not been incorporated in the analysis. While the exact numbers could vary slightly, the broad inference is that even for the Indian grid which is heavily coal dependent, EVs have a significantly lower carbon footprint than ICE.

Now, to the second question around life cycle emissions of an ICE vehicle vs an EV. Again, the quantification of carbon emissions over the entire life cycle of an ICE vehicle and an EV is tough.

Except for the Li-ion battery, the rest of the EV is similar to an ICE vehicle and hence, a simplistic assumption is being made that an ex-battery EV has the same carbon footprint as that of an ICE. That's a very conservative assumption given that an ICE has far higher number of components and is certainly likely to have a higher carbon footprint as compared to an ex-battery EV.

The CO_2 emissions over the battery life cycle are again difficult to estimate. At the higher end of the reported numbers, studies indicate that a 30 kWh Li-ion battery contributed to 5MT CO_2 through its entire life cycle. An EV in India would thus, take about 3.5 years to net off this additional CO_2.

Without over-emphasising on how good EVs are, the broad message is that EVs are more carbon efficient when compared to ICE vehicles in India.

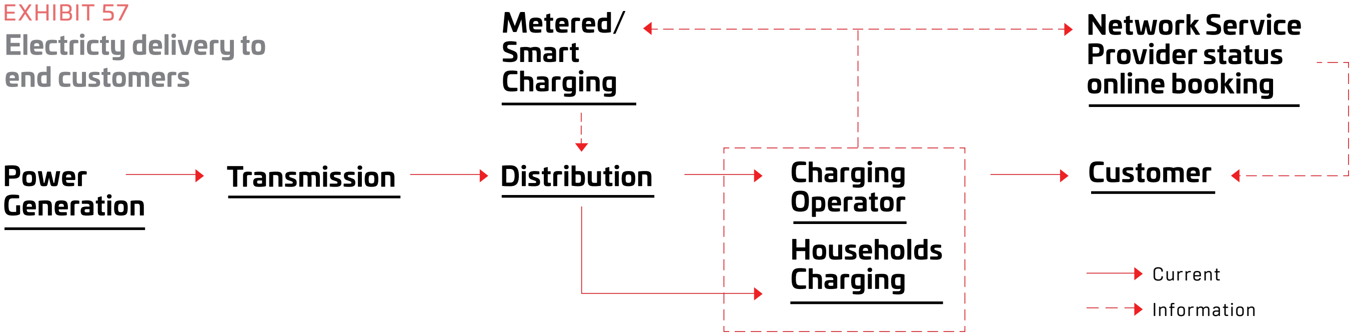
2 / GRID COMPOSITION

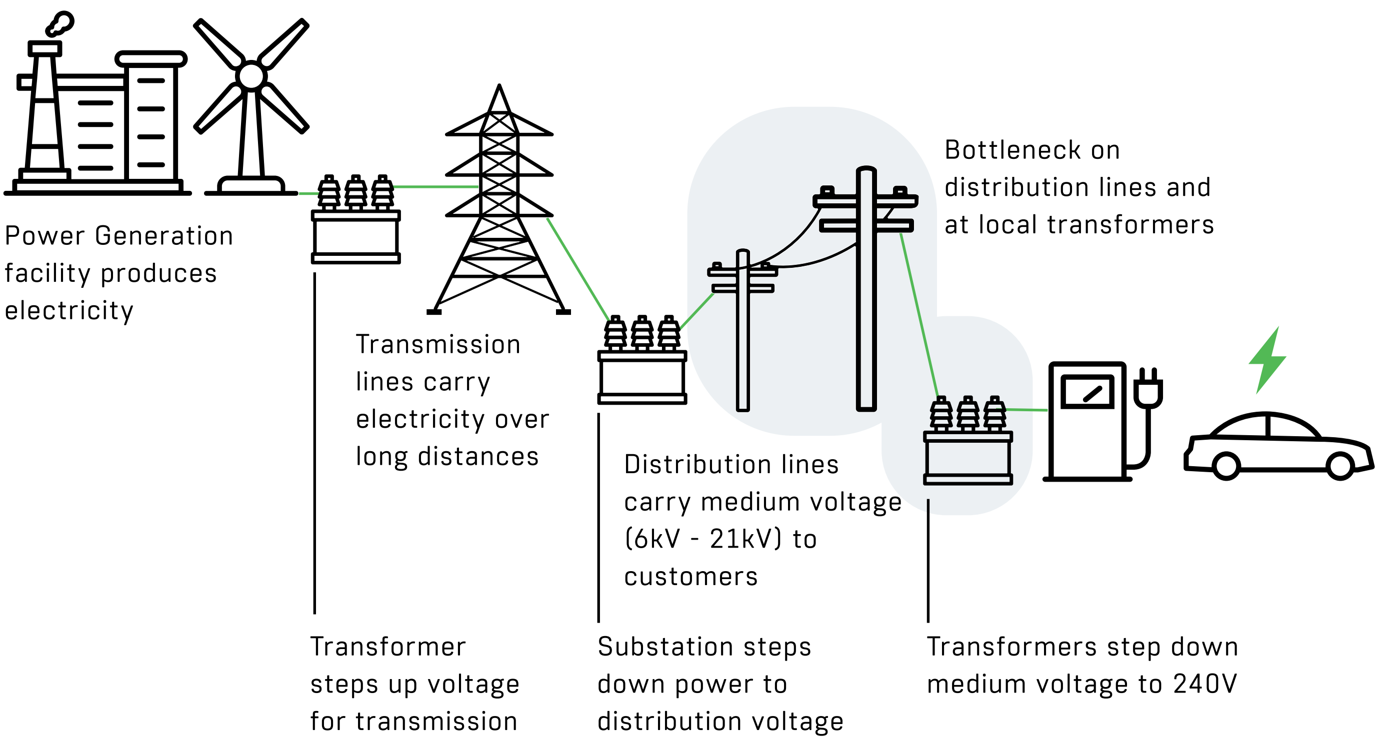
EVs are better than ICEs even with the current coal-heavy grid mix; A shift away from coal, however, is a must to truly address the pollution problem

EVs are an enabling mechanism to address the pollution problem. To truly address this, the Indian grid will have to become more carbon efficient. A reduction is needed on the reliance of coal fired power plants and an increased contribution from solar and wind energy into the grid. The larger policy vision seems to be aligned with this objective as well. If India reduces coal-based electricity to 30% of the grid, then an electric car in India would have 1.5 MT/year CO_2 emissions. This means means an EV would break-even with an ICE within 1.5 years in terms of the CO_2 footprint.

EXHIBIT 57

Electricty delivery to end customers





3 / GRID CAPABILITY

A sustainable and efficient grid is needed to develop customer's trust in electric vehicles

Adoption of vehicles will not just depend on the automobile industry. It requires significant support from power and technology sectors to create a charging ecosystem that can reduce the stress of EV charging for the people.

The diagram represents how electricity is delivered to the end customers. Power plants generate electricity and increase the voltage as power is transmitted to the transmission lines. The transmission lines bring power to a substation near a population centre to step down the voltage. From the substation, the power is delivered at a medium voltage of (2.2kV – 33kV) to smaller transformers, which step down to the appropriate voltage for connecting EV chargers. This AC is then converted to DC in the fast charger to match the battery voltage of the vehicle.

4 / GRID CAPABILITY

Power generation and transmission needs upgradation and at a faster pace

As EV penetration is currently low, there should not be a major impact on transmission and power generation infrastructure. But it is estimated that EVs alone would consume about 1.2-1.5 GW of power in Delhi. This is expected to form about 25-30% of the city's current requirement. This would require upgradation of lines and development of infrastructure in the coming years.

India has taken initiatives which help in reducing this issue. The country has also been upgrading to high power distribution lines in order to upgrade to efficient transmission systems.

EV charging can be a boon to solar based electricity generation in India, if managed well. EV charging during the day can act as mass storage systems that can utilize significant solar power, balancing the load. This will improve performance and lead to the efficient use of this renewable source.

5 / GRID CAPABILITY

Distribution would be impacted significantly by concentrated EV adoption

Adoption of EVs will grow in concentrated groups, as consumers tend to get influenced by EV purchases in their vicinity. If 10% of households in a block switch to EVs with a Level 1 charger in their homes, it is estimated that it would add around 20% of peak additional load. This would require significant upgradation to the present distribution system. Utility providers in other countries are providing discounted pricing for charging during non-peak hours to reduce the impact on the grid. That is not the case in India. In China, a study of 27 residential communities was carried out. It revealed that when EV penetration had reached 20% in 21 communities, the local grid required an upgradation.

In India, a majority of transformers are of <100 kVA capacity. Adding even one Level 2 wall mounted charger (3kW -22kW) along with the current usage would add significant stress on the transformer. Hence, a major upgradation is required in areas of higher adoption to meet the demand of EVs.

For higher level chargers, separate transformers are required to be installed. This would add to the expenditure of setting up EV infrastructure in India.

The upgradation of distribution systems also has positives. The low capacity transformers, which form the majority of transformers used today, are manufactured with conventional materials which results in very high power loses of around 16% (compared to global average of 1-2%). The higher capacity transformers will help reduce these losses and thus, reduce the electricity charges going forward.

6 / GRID CAPABILITY

New business opportunities for management of EV charging supply-demand dynamics

An EV charging operator would also require engaging with a Network Service Provider (NSP) to interact with customers. As EV charging (unlike refilling fuel in combustion vehicles) takes significant amount of time, it requires proper communication with customers to avoid demand-supply issues. There have already been a few instances where there were huge queues of vehicles outside stations causing traffic jams and problems to the surrounding neighbourhood. An EV charging operator should be able to show the current and future status of chargers, provide a facility to book slots remotely, provide invoicing, etc. This would create significant opportunities for start-ups to establish platforms for the EV charging management.

7 / GRID CAPABILITY

Smart/metered charging will be the future

In metered charging there is communication from the grid, depending on its load, which influences the behaviour of charging by using variable tariffs, charging limitations, etc. In more advanced systems, it can directly communicate with the vehicle during charging. It tries to balance the load on the grid and reduces the peak requirement by using the EV as energy storage systems. This is mainly at ideation stage and requires high level development in EV infrastructure and communication. There are pilot facilities in developed countries adopting this at a smaller scale. Tesla also has a system where the charging rate is reduced when many cars are simultaneously connected, to avoid exceeding limitations of the transformers and other equipment.

Another advanced application in this field is Vehicle to Grid (V2G) charging. In this technology, the vehicles act as energy storage devices. Batteries in vehicles can transfer the current back into the grid when the grid demand is high and gets charged when the grid demand is low. This reduces the energy charges for batteries and balances the grid. However, this requires a high level of communication between the grid and the vehicles, and, compatibility of transferring current back to the grid.

Battery Recycling

1 / First step — second life

End-of-life EV batteries have large potential applications in stationary storage systems. Second life batteries find applications in a variety of services including frequency response, backup power, demand side response and auxiliary capacity. Batteries are also being used for energy storage coupled with EV charging, in order to reduce stress on the grid and to decrease the demand during peaks. The concept is rapidly picking up in the USA and China where second life battery availability is increasing.

In China, new regulations call for battery and vehicle companies to arrange for both recycling and assessment of second life potential. The Li-ion adoption and awareness in the Indian ESS market is gradually picking up. Li-ion is expected to replace Lead Acid for commercial UPS, renewable integration and Telecom ESS applications. Second life Li-ion batteries could make an interesting case for the cost sensitive home UPS market as well, where Li-ion ESS would otherwise find it tough to penetrate.

2 / Circular energy – key to India's self sufficiency

India has virtually no reserves of key battery materials like Lithium and Cobalt. The industry in India will depend upon the import of these materials in the early phase of its growth. With EV adoption picking up pace by FY25, the end-of-life Li-ion battery market is expected to grow to ~100,000 tonnes by FY30. Recycling of these batteries is critical for India to keep the import dependency at a minimum.

Not all end-of-life batteries are expected to reach the recycling stage, as a large portion of them are hoarded or just disposed off. Non-availability of a sophisticated supply chain is partially a reason for that as well. Even if one considers a 50% recycling of end-of-life batteries, that represents a market opportunity of USD 0.8 billion by FY30.

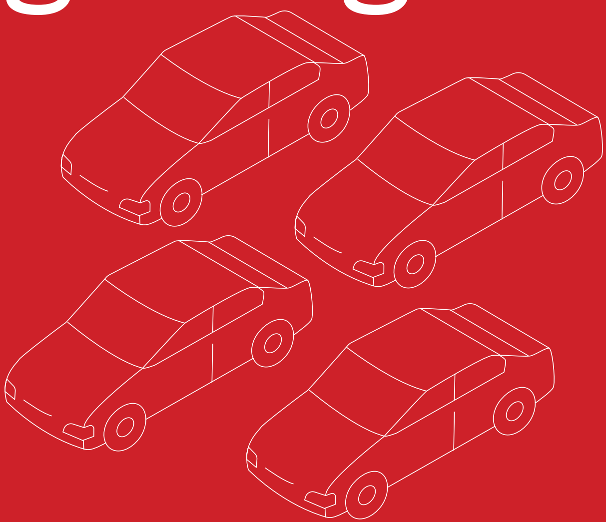
EXHIBIT 58

Recyclable material in Li-ion batteries

MATERIAL	USD/Kg	% CONTENT IN A CYLINDRICAL CELL (18650)							
		NCM111	NCM523	NCM622	NCM811	NCA	LFP	LMO	LCO
CASING									
STEEL	0.3	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
ALUMINUM	1.8	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
CURRENT COLLECTORS									
ALUMINUM	1.8	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
COPPER	6.0	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%	7.0%
ANODE MATERIAL									
GRAPHITE	1.2	18.1%	18.1%	18.1%	18.1%	18.1%	18.1%	18.1%	18.1%
CATHODE MATERIAL									
MANGANESE	2.4	6.1%	5.5%	3.6%	1.8%			19.4%	
LITHIUM	70.0	2.3%	2.3%	2.3%	1.9%	2.3%	1.4%	1.2%	2.3%
COBALT	30.0	6.5%	3.9%	3.9%	1.9%	2.9%			19.3%
NICKEL	12.0	6.5%	9.7%	11.6%	15.4%	15.4%			
ALUMINUM	1.8					0.4%			
IRON	0.4						11.3%		
TOTAL VALUE (USD/KG)		**5.4**	**5.0**	**5.2**	**4.8**	**5.3**	**2.0**	**2.3**	**8.3**

09

A New Beginning



The dawn of clean energy disruption

While concluding this whitepaper on electric vehicles, it would be apt to put the EV transformation in context with the larger picture of clean energy disruption. Today, solar energy has become more economical than thermal power plants, something that was unimaginable 10 years ago. General Electric Company (GE) exemplifies how an inability to keep up pace with rapid industry transitions can erode value. GE destroyed an unprecedented USD 193 billion or 74% of its market capitalization between 2016 and 2018. This value destruction was driven in large measure by the collapse of the new thermal power construction market globally, and GE's inability to adapt to the new energy regime. This is also a reflection of how fast disruptive changes can alter industry structures.

In the future with rooftop solar, there will be no centralized energy generation and distribution. The grid would become decentralized. When this clean energy powers electric vehicles, the transportation industry would truly become clean. The next areas of this disruption are shared mobility and autonomous driving. Unlike today, where everyone owns a car, which ends up being parked for a majority of time, mobility, in the future, will be shared and available on demand, powered by electric vehicles and in the long term, be autonomous.

Electric vehicles are not just about disrupting the ICE automobile. They are part of the larger disruption in energy and transportation. The way of living is going to transform and EVs will be an essential part of the new way of life.

EVs are undeniably superior products and a technological disruption to the ICE vehicles. In a span of less than 15 years, at the start of the last century, the USA went from nearly 100% horse carts to almost 100% gasoline cars. When the first call was made over a mobile phone in India in 1995, it seemed like a niche product that wasn't meant for the masses. It took the government 8 years to weed out all the inefficiencies in the country's telecom policy. In 2003, there were a mere 13 million mobile phone subscribers and 97% of the market share was controlled by 2 companies. Today in 2020, India has 1.2 billion mobile phone subscribers and those two companies hold less than 10% of the market share.

The world has witnessed disruptions time and again, yet every new disruptive innovation is met with a lot of cynicism in the initial stages. Like the beginning of every disruption, electric vehicles are also surrounded by uncertainty. At what pace EVs will be adopted is a question that has bewildered everyone and despite all the views in the market today, including ones in this whitepaper, it is hard to accurately predict the same. Notwithstanding the challenges around estimating the pace of adoption, what one needs to appreciate is the inevitable reality that in the near future, EVs are going to define the new regime of mobility.

GLOSSARY

2W	2-Wheeler
3W	3-Wheeler
4W	4-Wheeler
AC	Alternating Current
B2B	Business to Business
B2C	Business to Consumer
BEV	Battery Electric Vehicle
BCD	Basic Custom Duty
BLDC	Brushless DC Motor
BMS	Battery Management System
BOP	Balance of Pack
BS-VI	Bharat Stage VI
CAFE	Corporate Average Fuel Economy
CBU	Completely Built Up
CKD	Completely Knocked Down
COVID-19	Coronavirus Disease 2019
CPO	Charge Point Operator
DC	Direct Current
DHI	Department of Heavy Industry
E-2W	Electric 2-Wheeler
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
FCEV	Fuel Cell Electric Vehicle
FOC	Field Oriented Control
GCC	Gross Commercial Contract
GST	Goods and Services Tax
GWh	Gigawatt-Hour
ICE	Internal Combustion Engine
kWh	Kilowatt-Hour
LFP	Lithium Iron Phosphate
Li-ion	Lithium ion
LMO	Lithium Manganese Oxide
LTO	Lithium Titanate Oxide
MNRE	Ministry of New and Renewable Energy
MT	Metric Ton
MWh	Megawatt-Hour
NCA	Lithium Nickel Cobalt Aluminum Oxide
NCM	Lithium Nickel Cobalt Manganese Oxide
NEMMP	National Electric Mobility Mission Plan
OEM	Original Equipment Manufacturers
PHEV	Plug-in Hybrid Electric Vehicle
PMP	Phased Manufacturing Programme
PMPM	Permananet Magnet Synchronous Motor
SKD	Semi Knocked Down
SMEV	Society of Manufacturers of Electric Vehicle
SoC	State of Charge
SoH	State of Health
STU	State Transport Units
TCO	Total Cost of Ownership
W	Watt
Wh	Watt-Hour

SOURCES

EXHIBIT 1
Alternative Fuels Data Center of US Department of Energy,
ACMA, Rolland Berger, Factor Daily

EXHIBIT 2
Beaudaniels,
ACMA, Rolland Berger, Factor Daily

EXHIBIT 5
Analyst Reports, Avendus Research

EXHIBIT 6
Post and Beyond Lithium-Ion Materials and Cells for Electrochemical Energy Storage – Google talk by Andreas Hintennach (Daimler)

EXHIBIT 8
Avendus Research

EXHIBIT 9
Analyst Reports, Avendus Research

EXHIBIT 12
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EXHIBIT 13
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EXHIBIT 14
Bloomberg NEF, Avendus Research

EXHIBIT 15
Bloomberg

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Analyst Reports, Avendus Research

EXHIBIT 17
Avendus Research

EXHIBIT 18
Phys.Org

EXHIBIT 23, 24
Company Websites; Statista; EV Blogs: Wattev2buy, Carsguide, Cleantechnica, Insideevs, Electrek

EXHIBIT 25
Bloomberg

EXHIBIT 28
Analyst Reports, Avendus Research

EXHIBIT 29
Analyst Reports, Avendus Research

EXHIBIT 32
National Automotive Board, Department of Heavy Industry

EXHIBIT 33, 34, 35
Department of Heavy Industry

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Company Websites, Avendus Research

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Analyst Reports, Avendus Research

EXHIBIT 47
Analyst Reports, Avendus Research

EXHIBIT 53
Statista, IEA, Norsk Elbilforening, News Articles

EXHIBIT 58
Circular Energy Storage

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