



EVCONNECT

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NEWSLETTER

INSIDE THE ISSUE

Power Talk

In conversation with Dr KP Krishnan
Secretary, Ministry of Skill Development and
Entrepreneurship, Government of India.

Updates from the World

- Electric vehicles mean more power to you
- Europe launches multibillion-euro initiative for electric car batteries
- Factcheck: How electric vehicles help to tackle climate change

Updates from India

- Govt plans 400 MW storage-linked renewable projects
- Panasonic launches first of its kind EV charging service for India
- India to frame indigenous EV charging station norms

EV @ WRI

How to Enable Electric Bus Adoption in Cities Worldwide

EV Feature

Winning job opportunities from vehicle electrification in India
by Neha Yadav, Research Consultant, WRI India

FROM THE CEO'S DESK

Dear Friends,

I am pleased to present to you the tenth issue of EVConnect.

India is clear on its intent to switch to electric mobility. This will mean that we will need a local supply chain of electric vehicles (EV) and its systems like batteries, chargers and other infrastructure. To make these successfully the Indian workforce will need to learn a new set of skills. In this issue, we explore the theme of skill development in the context of the emerging EV sector; what the country must do to prepare for this transition and what it takes to create a globally competitive labour force. We also discuss other important developments that recently took place in this domain.

New developments are taking place at a very rapid pace, and it is often difficult to keep up-to-date. These are reported through multiple media channels and are hard to track. This newsletter seeks to bring together several of these developments into one accessible document. We hope this curated and compiled content will come in handy to those who are seeking the latest information on electric mobility.

This edition of the newsletter includes a conversation with Dr KP Krishnan (Secretary, Ministry of Skill Development and Entrepreneurship, Government of India) who sheds lights on how India should prepare for skilling as the electric vehicle industry grows in the country. We also present a feature that maps the shift in jobs as electric vehicles replace conventional ones to inform the strategy to re-skill existing workforce and prepare the incoming one.

We hope you find this edition of the newsletter beneficial and share your thoughts so that we can improve further.



Sincerely,

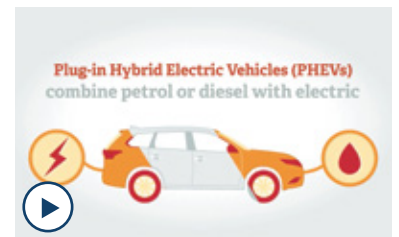
Dr. OP Agarwal
CEO, WRI India

WATCH

Presenting the montly EV Connect Powertalk interviews exclusively discussing insights from EV experts. We also present one hand picked video to showcase EV innovations from across the world.



Power Talk with Dr KP Krishnan,
Secretary, Ministry of Skill Development
and Entrepreneurship, Gol



Types of Electric Vehicles Explained



POWERTALK

IN CONVERSATION WITH DR KP KRISHNAN

SECRETARY, MINISTRY OF SKILL DEVELOPMENT AND
ENTREPRENEURSHIP, GOVERNMENT OF INDIA.

*Interview taken by Neha Yadav, Research Consultant, WRI India
(Copy-edited for the print version)*

“The national market for labour is what motivates the Government of India (GoI) to enter the picture. What this means is that you could train a person in Assam and s/he could end up working in Gurugram.”

“In India, approximately 90%+ of the workforce is in establishments that are formally classified as informal. We are talking about establishments that have an employee strength of just 1 to 1.5 persons on an average.”

“An organisation like WRI can gaze into the future and tell me approximately this is the direction the world is going in and very likely, with some adaptation and modifications, India will move in the same direction.”

Interviewer: India intends to switch to electric mobility. This will need a local supply chain of electric vehicles (EV) and its systems such as batteries and chargers. To make these, the Indian workforce will need to learn a new set of skills. In your opinion, what should the country do, in the short, medium and long term, to prepare for this transition and successfully create a globally competitive labor force?

Mr Krishnan: Before I get into the specific details of how India should prepare for the skilling requirements of the EV sector, it is perhaps useful for us to know the background on issues related to skilling generally and more particularly skilling in a federal context. Let me start with the second point. Skilling or vocational education, because that's the word used in the constitution, is a concurrent list subject. In plain English, it means the responsibility in terms of public policy and legislation is split between the state legislatures and the national parliament. And why is that so? The logic is skilling is typically very local. There are a number of skills that you may require in Assam, which may not be relevant for Vijaywada. The skilling that you require in Spiti valley may not be needed in a coastal state like Tamil Nadu. Largely, world over, skilling is delivered locally but why then make it a concurrent list subject? The national market for labour is what motivates the Government of India (GoI) to enter the picture. What this means is that you could train a person in Assam and s/he could end up working in Gurugram. If you have a standard which is national, mobility of labour across India becomes easy. So, in short, while the national labour market consideration give a role for the (GoI) and the union parliament, intensely local demand and local conditions make skilling a state subject in India. In that context, what has GoI done? GoI primarily does the eco-system creation, and the framework for recognition of individual certifications of institutions. Plus given the federal taxation structure, typically GoI brings more money to the table than an individual state government. So GoI typically has been doing a lot of the funding. Execution has been between GoI and, within GoI, many ministries and state and local governments. And with this background, we need to spend another one minute on what exactly does a government do in skilling? If you look at all the successful OECD type countries, which have a great record in skilling and livelihood generation post-skilling, the one point that will stand out is that skilling is actually led by the employer. Skilling is not led by the government or governmental bodies.

“Skilling unlike education is learnt at work. You can do the theoretical component in the classroom. Therefore, two things need to be kept in mind for skilling – 1) that skilling is employer-led; 2) in skilling, the role of central government is relatively limited, but that of state and local government’s role is likely to be higher.”

“By its very nature EVs are going to be an organised industry. If there is an organised industry, employer connect becomes very easy. And an industry, which is starting today, will be very keen to invest in creating human resources required for the setting-up of the entire chain of manufacturing – i.e. the vehicles, the batteries, the maintenance – the entire value chain in essence.”

And what is the logic? There is a general concept of a mechanic, but how does this mechanic fit into Maruti is very different from how he will fit into Tata Motors or in a garage which is servicing Mercedes vehicles. So typically, skilling is led by the employer and is done at the workplace. In other words, skilling unlike education is learnt at work. You can do the theoretical component in the classroom. But actual skilling, the things which you do with your mind, hand and body – the coordination – is typically learnt at work. Therefore, two things need to be kept in mind for skilling – 1) that skilling is employer-led; 2) in skilling, the role of central government is relatively limited, but that of state and local government’s role is likely to be higher. In this context, what will the Government of India do vis-à-vis EV skilling? We have a whole bunch of what we call in our jargon ‘job roles’ – e.g. the word ‘doctor’ has a precise meaning in your mind, does the word carpenter have an equally precise meaning? So, the world has devised the classification of occupations. Just as there is a doctor, a nephrologist, an anaesthetist, a neurologist, there is a carpenter of level x, another of level y and so on. Such is the case for all job roles. We have many job roles in the auto sector but I will take one example – that of a motor mechanic. We are in the process of completely re-writing the job role of a motor mechanic. In fact it is co-incidental that as we speak, tomorrow at Manesar, my Directorate General of Training is meeting with practically everybody in the sector to generate in the next month a 4-6 weeks module on EV. All aspects of EVs will feed into a one-year programme for motor mechanics that we will run across 15,000 Industrial Training Institutes (ITI) in India. Plus, there is another hierarchy which is called the National Skill Trainers’ Institute (NSTI) of which we have one in each state. NSTI creates the trainers who train the trainees. So for the trainers as well as the ITIs this module will be ready in the next one module beginning from Fall 2019 semester.

Interviewer: What challenges could the country face as new EV-related skills replace traditional skillsets in both large and small firms?

Mr Krishnan: In my opinion, the challenges in skilling, when it comes to EVs, will actually be less complex than the challenges that we otherwise face in skilling. In India, approximately 90%+ of the workforce is in establishments that are formally classified as informal. We are talking about establishments that have an employee strength of just 1 to 1.5 persons on an average. In other words these are your mom and pop stores. It’s going to be your neighbourhood auto garage, cycle puncture shop etc. In terms of numbers, these establishments constitute over 90% of India’s workforce. Now, a bulk of India’s skilling ecosystem is focused on the balance 10. I run institutions like ITIs and the National Skill Development Corporation, all of which deal with the formal sector. The formal sector is very easy to work with. There is a Telco, Maruti, Hyundai, Ford, who know the value of skilling. You don’t need to educate them on productivity gains that come from skilling. A bulk of the EV challenge is going to be in the formal, organised sector. What I envisage today is EVs isn’t going to be a cottage industry. By its very nature EVs are going to be an organised industry. If there is an organised industry, employer connect becomes very easy. And an industry, which is starting today, will be very keen to invest in creating human resources required for the setting-up of the entire chain of manufacturing – i.e. the vehicles, the batteries, the maintenance – the entire value chain in essence. Plus, this sector already knows that technology is going to change rapidly, which means that they will be conscious of the need for continuous re-skilling and up-skilling. So my own sense is that if we can find a representative body of



employers, the challenge of skilling in the sector is going to be relatively easy because typically the body of employers gives me the domain – what is the current technology, what is their requirement etc. And the requirements are not limited to the domain because there may be a bunch of soft skill requirements too. There may arise a need for the employee to know English or to be able to read a manual which is in some other language, or a need to be able to operate digital interfaces. So there are hard, soft, financial sector skills, digital and app-based skills – a whole package that an employee needs to know. That is very easily organised when my counterpart is an organised sector like the EV industry. Typically the government funds the training. An individual employer's fear is "I pick you up, train you and make you an excellent EV mechanic and some other party poaches you. So all of the investment that I have made in you is benefitting my rival." The industry will be willing to collaborate on giving knowledge, *gyaan* domain knowledge, opening their premise for use but they don't want to pay for the training till they see the employee staying with them. So how this works out is that there is a small bit of contribution that comes from industry, which is very low. If the job is aspirational enough, the employee or prospective employee will pay a part, and the government picks up the rest of the tab. And we have enough money for that.

Interviewer: Until now, the participation of the women labour force in the automotive sector has been minimal. In your opinion, is it possible to take advantage of the shift to electric vehicle technology to increase the share of the women labour force in this sector? What would be some key steps that the country needs to think about?

Mr Krishnan: Thank you, that's actually a very good question. I am glad you asked me. This is a struggle that we are facing, again not merely in the EV sector. There is a larger story of falling female labour participation in the workforce in India, which has a whole bunch very complex explanations – societal, historical, religious etc. I don't want to get into that. But there is also a clear gender bias in the way, historically, the national skills qualifications framework has evolved. I'll explain what I mean. The national skills qualification framework is a competency-based framework. In other words, it will say x is certified as a carpenter if x has A, B and C skills; s/he can use a saw and cut a piece of wood to this thickness and this fineness. I am putting it crudely but there is a whole bunch of competencies that are associated with specific job roles. What has happened is historically you and I have had some sense of the strength required – for instance, for a mechanic's job or a fitter's job – we have assumed it requires physical strength. So, the way it is written, and if you actually see it through a close lens, you can see the gender bias. We have almost ruled out females from getting into many of these courses because the physical requirements of these competencies have exaggerated the gender negativity. We are now striving to undo that. In other words, we are now taking each job role and looking at it through three lenses – the gender lens, the green lens and a person with disability lens. For instance, the world is discovering that the hospitality sector has tremendous advantage for people with mental disabilities. Why? They are extremely good at repetitive tasks; you give them a task and they will do it to 99.9% perfection. There is a chain of hotels in India, Lemontree, which goes out of its way to recruit people with disability for a business reason and not just as a social cause. Gender is an important component. And where things are actually looking up is in the IT related

courses in the ITIs. The explosion in female registration, in the last 4-5 years, is to be seen to be believed. With jobs getting smart, and getting an IT component, job roles are becoming less physically demanding. The requirement now is of more intellectual and cerebral skills that are strength-neutral and this is making the gender debate that much easier. I don't see outcomes tomorrow but the nature of those job roles makes me believe that participation by females in this sector will be automatic and high - much higher than the typical auto mechanic courses.

Interviewer: What do you think will be the role of the Ministry of Skill Development and Entrepreneurship in transitioning to skills relevant to electric vehicles?

Mr Krishnan: I am glad that you have used the full name of the ministry. There is a skill development side and there is clearly an entrepreneurship side. I am not a domain expert on EV and but as I see the evolution of EVs,, I see an enormous amount of local entrepreneurial requirement. This is because there is a manufacturing and constant charging part, and then there is an upkeep of the vehicle part, a lot of the latter will not necessarily be done by the company via its own outlets. There will be franchisees and a whole bunch of local entrepreneurs who would need to have domain knowledge of EVs but there is a need to be entrepreneurial. They are not employees, but they are going to be running outlets of their own. I see enormous amount of scope for generation of entrepreneurs who have the required EV domain knowledge. The entrepreneurial domain knowledge we will provide which can become an important part of this chain. The other part as I mentioned is the creation of fresh manpower for manufacturing and maintenance. The conversion or upscaling and upskilling of of the existing auto workforce and familiarising them with EV technology, in addition to conventional auto knowledge, is clearly another challenge. My sense is there is a short-term agenda, there is a long-term training agenda, and then there is something called recognition of prior learning, in our jargon. These are people who would have learned the EV ecosystem on their own, the way we typically see a carpenter who hangs around with his dad and he picks up an axe and learns the work. There are a whole bunch of people who have learnt their job that way. Recognise their work, formally certify them, upscale them – so I see a role for us in all three pillars – i.e. short-duration training, long-duration institutional training, and recognition of prior learning which includes upskilling and re-skilling. However this will require a strong collaboration with the collective body of employers and establishments which are in the business domain.

Interviewer: What do you think is the role of research organisations, like WRI, in helping with this transition?

Mr Krishnan: The role of bodies like WRI, is to translate what is happening in this industry into meaningful targets for me. We have long ago moved from a central planning model of the Indian economy. There is no input–output model that concludes that India will produce 4083 electric vehicles, I need x amount of iron, x amount steel and x number of batteries. We are now a much more market driven economy. But skills, the world over, is an area which is characterised by a lot market failure. And why? Because there is what is called information asymmetry. An organisation like WRI can gaze into the future and tell me approximately this is the direction the world is going in and very likely, with some adaptation and modifications, India will move in the same direction. So, approximately a year or two from today, the requirement of India is likely to be x type of manpower in sector A, y number manpower in sector B. And this again is something WRI cannot do alone. It needs to be done in collaboration with the industry. But an organisation like WRI is much better placed than the government to do this interfacing because governments are not typically well organised in many of these research type issues. My best bet would be to get into collaborative arrangements with institutions, like WRI, which become a partner in the larger EV story. There is a sub-story on skilling and that's a story where I look forward to greater collaboration with WRI.

Interviewer: What are some of the important research questions that can be taken up at this point?

Mr Krishnan: The research question from the perspective of skill development is: I have a framework called the National Skills Qualification Framework. India has something called a National Classification of Occupations. So, the research questions for me would be can you come up with clear job roles: give me the title of the various job roles that will emerge in the EV sector and enable me, sitting with my team, to define the competencies that will be required, and this is not just a carpenter and electrician exercise. Because this is also going to impact higher education. Engineers coming out of IITs and other engineering schools would need to have the knowledge component. So, the research questions that I see are: Can we identify the knowledge gaps and skills gap, and carry out something called a skill-gap study? That's a core applied academic research question, that's the area where I see the greatest role.



UPDATES FROM THE WORLD

Electric vehicles mean more power to you | *Market Development*

This article illuminates the efficiency gains and what they imply for the society as the number of electric vehicles exceeds internal combustion engine (ICE) vehicles in 2040. The change in energy mix is likely the biggest implication of the growth in electric vehicles. This is because, as BloombergNEF predicts, by 2040 EVs are going to displace 10 million barrels of oil on a daily basis. Not only will the EVs rely on electricity but the need for energy will be much lesser because EVs turn 60-70% of the energy to power wheels whereas conventional vehicles use only 20% of the energy. With the rise in renewables, electricity is likely to be cleaner as well.

Takeaway for India: These are important lessons for India as the average vehicle owner in most instances doesn't have a garage attached to his/her home where the electric vehicle could be charged. The lessons learned also reiterate the importance of having a dense charging station network in cities. Lastly, options such as battery swapping could be explored which adds the same range to the vehicle in a much shorter duration. [Read more](#)

Europe launches multibillion-euro initiative for electric car batteries | *Strategy and Market Development*

Reliable battery technologies are key to dispelling "range anxiety" for electric vehicles. Lack of such batteries is holding back the uptake of EVs in Europe. France and Germany recently formed a partnership to create a local supply chain of battery manufacturing. An investment plan of USD 5.6-6.7 billion will see a pilot factory, with around 200 employees, open in France in the coming months. A host of systems will be explored such as recycling, secondary usage of batteries and various chemistries.

Takeaways for India: Creating a local supply chain of battery manufacturing is important. However, India doesn't have the mineral reserves that go into the making of batteries. In this case there could be two options – Enter into international partnerships with battery manufacturers and invite them to 'make in India' or find a technological solution, such as recycling batteries, to mine raw materials to feed into the making of new batteries locally. [Read more](#)



Factcheck: How electric vehicles help to tackle climate change | Policy

Electric vehicles are important in meeting the greenhouse gas mitigation goals. This study, done on electric vehicles in Europe, found that EVs contribute to much lower emissions, over their lifetime, than conventional vehicles across Europe as a whole. In countries with coal-intensive electricity generation, the benefits of EVs are smaller. However, as countries decarbonise electricity generation with renewables, to meet their climate targets, driving emissions will reduce for existing EVs and manufacturing emissions will fall for new EVs. Comparisons between electric vehicles and conventional vehicles depend on a host of factors such as the size of the vehicles, the accuracy of the fuel-economy estimates used, how electricity emissions are calculated, driving patterns and even the regional weather. There is no one size fits all method for comparison.

Takeaway for India: From India's perspective, while adoption of electric vehicles will help reduce greenhouse gas emissions; business and policy measures, to increase the share of clean sources in the energy mix, should be ambitiously pursued. EV batteries have an additional advantage, in that they can be used in their secondary life for storing renewables and feeding them back to the grid, further reducing the CO₂ intensity per kWh. [Read more](#)

Govt plans 400 MW storage-linked renewable projects | *Strategy, Market Development*

To boost the nascent power storage industry, the Indian government is coming up with 400 MW of renewable energy tenders for round-the-clock (RTC) electricity supply. Storage-backed power, from these sources, would be supplied to the New Delhi Municipal Council (NDMC) and Dadra and Nagar Haveli. Since solar and wind are weather dependent, and hence inconsistent, energy storage systems will play a major role in increasing renewable energy capacity. Having assured demand would significantly mitigate risks generally associated with storage-linked renewable sources. Experts highlight that the market for energy storage would grow to over 300 giga-watt-hour between 2018-2025 and India could attract investment of over USD 3 billion in the next three years. [Read more](#)

Panasonic launches first of its kind EV charging service for India | *Market Development*

Panasonic has launched a unique EV charging service in India - Nymbus. This combines physical components such as charging stations, swap stations, onboard charges and telematics systems, and virtual components like cloud service, analytics, intuitive dashboard and artificial intelligence to deliver a one-stop solution. Panasonic has partnered with SmartE for deploying 150 SmartE electric three-wheelers and with qQuick 25 2-wheelers in the Delhi NCR region. The service allows users (individual EV users, EV fleet owners, e commerce & logistics companies) to generate real-time data and reports from continuous operation thus enabling them to use their fleet in the most efficient way. [Read more](#)

India to frame indigenous EV charging station norms | *Policy*

India plans to devise its own standards for charging stations for its electric vehicle ecosystem. The Bureau of Indian Standards (BIS) and the Department of Science and Technology (DST) are working on an indigenous charging standard. Thus far, three acceptable global standards exist - Japanese, Chinese and European. Currently, companies who set up charging stations in India need to buy the license from the authorities in Japan, China or elsewhere, which adds to the expenses significantly. Indigenous standards will help bring down the costs of establishing charging stations which are vital to the growth and up-take of electric vehicles in the country. [Read more](#)



EV @ WRI

How to Enable Electric Bus Adoption in Cities Worldwide

By Xiangyi Li, Camron Gorguinpour, Ryan Sclar and Sebastian Castellanos
- May 2019

Electric buses could pioneer a new age of clean and efficient urban transport and put cities on track towards sustainability. However, electric bus adoption is not accelerating fast enough for the world to meet transport-related global climate objectives and help limit global temperature rise to below 2 degrees Celsius.

The aim of this report is to fill in knowledge gaps and provide actionable guidance for transit agencies and bus operating entities to help them overcome the most common and debilitating barriers to electric bus adoption. It provides a step-by-step guidance to establish and achieve electric bus adoption targets using concrete and diverse real-world experiences. [Read more](#)



EV FEATURE

WINNING JOB OPPORTUNITIES FROM VEHICLE ELECTRIFICATION IN INDIA

by Neha Yadav, Research Consultant, WRI India | May 2019
Dr Parveen Kumar, WRI India, provided data and insights for the article.

India is poised to gain from the adoption of electric vehicles (EVs) and is moving intently in that direction. As EVs grow in share, and begin replacing conventional internal combustion engine vehicles, the ramifications of job loss from vehicle electrification raises many questions. In light of the substantial contributions of the automotive sector in generating employment, approximately 30 million¹ opportunities, the perceived risk to jobs is magnified manifold.

The primary purpose of this article is to allow readers to gain a deeper understanding of the jobs and industries that will be impacted from the electrification of vehicles in India. Given the context, in effect, this article maps the losses and gains in employment. It argues that the shift in jobs shouldn't be looked at as a binary situation. While electrification will indeed render some jobs obsolete, it will simultaneously create new jobs and new industries. At this juncture, it is in India's best interest to focus on understanding this shift and carefully planning a seamless transition. This will entail designing a set of steps that will successfully tap new employment opportunities, preempt the repercussions of jobs soon to be obsolete, and ensuring the adaptation of existing skill sets. This article recommends some steps in this direction.

It is expected that change in vehicular technology – from an Internal Combustion Engine (ICE) to a Battery Electric Vehicle (BEV) – will phase out several production processes in the core automotive sector and the supporting upstream and downstream industries. This is apparent because the composition of an EV is very different from that of an ICE vehicle. Moving from gasoline, diesel and CNG to batteries powered by electricity would also render some oil industry associated jobs obsolete. However, merely looking at the jobs that will be discontinued is just one side of the story. The transition from ICE to BEV will require manufacturing and production of new parts and processes, leading to an altered supply chain, which would invite the need for labour that employs a variety of new skills sets. In effect, while some job streams will perish, new jobs will be created.

India has the highest percentage of people under 25 in the world constituting nearly half the population of the country. Presence of a young population can be an asset, for the country, as the youth can actively support the industries that will be born out of electric mobility. The first step in this is understanding the areas where jobs are likely to emerge or fade away or hold potential for adaptation. The next step will be to understand the skill-sets needed for the technological change in the automotive industry. This will help in realignment of the labour market by creating a timely and steady supply of workforce that can readily contribute to the supply chains.

Furthermore, many state-level EV policies emphasise on the creation of sturdy EV supply chains by laying out a bouquet of incentives for automakers to manufacture in their states. Some are also creating new curriculums in state universities to create a labour force that is employable in the EV sector. The findings of this article highlight the sub-sectors and new industries – apart from the core automotive manufacturing – that the state governments could invite into their regions.

This article, first discusses how the automotive industry is structured, followed by the value chain of ICE vs electric vehicles. Thereafter, is the discussion on the job gains and losses; and the job profiles and level of skills needed to prepare a labour force that can meaningfully contribute to the new value chain.

Point to be noted here is that this article may be preliminary, but it is a timely attempt to understand these questions and encourage critical thought. Insights presented here are based on subject matter expertise and knowledge-based inferences. However, it is beyond the scope of this article to get into the granularities of job profiles and necessary skills in the context of EVs.

Geography of auto manufacturing in India

India² is expected to be the third largest manufacturer of vehicles in the world by 2020.

Geographically, the Indian auto industry is spread over five clusters³: Pune – Chakan – Talegaon cluster in Maharashtra, National Capital Region cluster, Chennai – Bengaluru – Hosur cluster, Sanand – Hansalpur – Vithalpur cluster in Ahmedabad, Pithampur cluster in Madhya Pradesh. In these clusters, auto-makers and auto-parts makers co-exist to create a localised value chain. In addition, there are several clusters that are dedicated solely to auto-component manufacturing⁴. These are located in Rae Bareilly in Uttar Pradesh, Silchar in Assam and Ahmednagar in Maharashtra.

The auto industry in India is structured into ‘Tiers’ which are present in each of these clusters. Tier 1 comprises the Original Equipment Manufacturer (OEM) (or the final consumer in the manufacturing; e.g. a vehicle manufacturer). This is followed by Tier 2 and Tier 3 which supply auto-components and provide other services to the OEMs. This is similar to the global practice. The further the Tiers, less complex is their product or offering. Typically, Tier 2 and 3 are located in the form of an umbrella of micro, medium and small enterprises around the vehicle manufacturers, who are their primary consumers. Tier 2 and Tier 3 supply auto-parts worth 60–70% of the total cost of an ICE car, for instance⁵. Parts suppliers beyond Tier 3 include many who have been formally classified as informal. Figure 1 shows the various auto clusters and auto component making clusters across India.

An increase in the production of electric vehicles will slow down the demand of ICE components which in turn will impact Tier 2 and Tier 3 players, and the informal players. These players will need to quickly upgrade their production processes to be a part of the new electric vehicle value chain. This will hold true both at the domestic and global market considering Indian players have been increasingly supplying ICE auto-components to other countries.

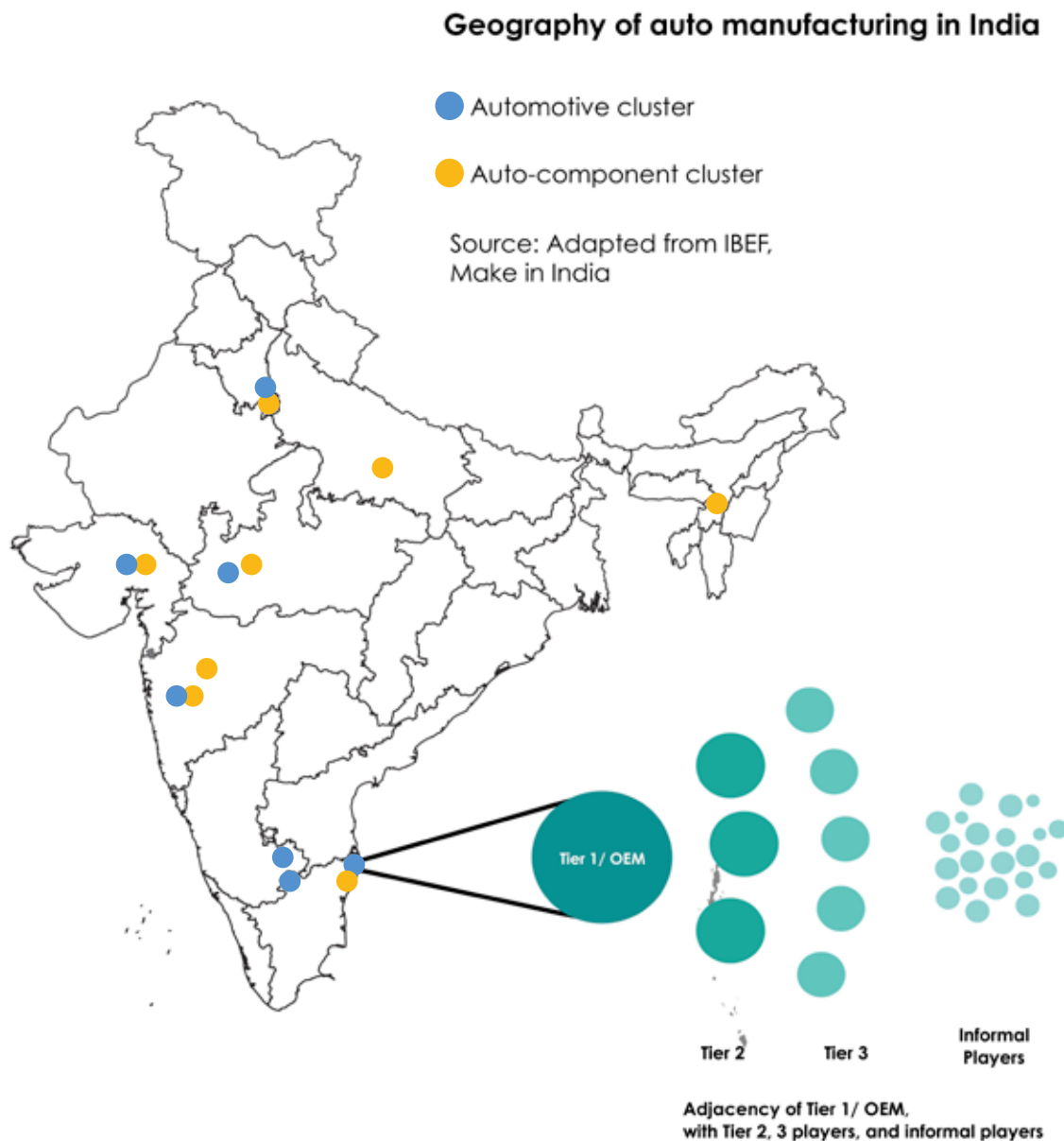
Deconstructing the value chain of the vehicles

The value chain of an ICE vehicle is different from that of an electric vehicle. This will help guide which new components and manufacturing processes will gain prominence and which ones will perish. The automotive value chain has three stages: upstream processes, core automotive manufacturing and downstream. We discuss each of these one by one below:

Core automotive manufacturing

To understand this, let us look inside the two powertrains – electric and ICE⁶. In terms of the mechanical design, an ICE vehicle is more complex as its power train has nearly six times more moving parts as compared to an electric powertrain. Similarly, nearly 60% fewer spare parts and much less maintenance is needed in an electric vehicle, which

Figure 1: Geography of auto manufacturing (vehicles and components) in India



shrinks the need for after-sales services which has traditionally been integral to driving an ICE vehicle. However, a point to be noted is that electric vehicles are far more complex than an ICE vehicle in terms of the electronics. For example, 6-10 times more semiconductor content, which is used to make power-electronic components, is found in EVs. Furthermore, an electric powertrain also contains a battery, made out of Lithium and Cobalt, which serves as an energy storage system. This energy is transmitted to the wheels with the help of a motor. For increased energy efficiency, the motor for an electric powertrain contains permanent magnets which are made out of rare-earths; 80% of which are supplied by China⁷. Rare-earths form the core of many clean energy technologies⁸. Their use is spreading widely in EVs too.

Therefore, to produce the new components for EVs, the automotive space will see new entrants that will support the core-automotive manufacturing. It will alter the share of content traditionally supplied by auto-component suppliers at the tier 2 and 3 levels. For instance, a comparison⁹ of EV and ICE vehicles in Europe shows that manufacturers of battery packs and Battery Management Systems (BMS) will be a new supplier, supplying as much as 43% of the vehicle content (in the case of EVs) while the power electronics content will increase to 11% of the total. By contrast, content supplied by auto-component makers and other parts suppliers will reduce to 44% - less than half of the original. The requirement for new content will prompt adjustment in production capacities, at various tiers, as well as changes in the workforce and skills.

Upstream and downstream processes

Making electric vehicles will need changes in the core automotive manufacturing, which in turn will require changes in the upstream and downstream processes¹⁰.

Upstream processes are the activities that take place to support the manufacturing of the vehicles. Upstream processes will support extraction of minerals such as for batteries and motors, metals to make vehicle bodies, fuels, and assembling of auto-components to make the vehicles. For instance, batteries will require the mining of lithium and cobalt, while motors and other components will need the mining of rare-earth elements. Much of these processes will take place in other countries as India doesn't have the reserves of critical raw materials like Lithium and Cobalt that go into batteries. In the case of rare earths, some extraction is taking place in India, but majority of the products are manufactured elsewhere.

Downstream processes take place after the vehicle is manufactured and are predominantly consumer-facing. These include auto dealerships, service centres, after-sale repair and maintenance, financing at banks, vehicle hires and rentals, fuel supply, transporting vehicles from manufacturing to retail site, vehicle scrappage and end-of-life management. In the case of electric vehicles, fuel supply will also include electricity production and distribution, battery storage, renewable energy, and the construction of charging and swapping infrastructure where vehicle batteries can be re-energised.

Figure 2: Comparing value chains of EVs and ICE vehicles to identify merging employment areas



Mapping the shifts in employment and skill dependency

Core automotive manufacturing results in directly related employment opportunities, whereas the upstream and downstream processes result in indirect job opportunities. As these processes undergo a shift and result in an altered value chain, we first do a broad visual map of the two value chains – of an EV and an ICE vehicle – to identify the jobs that will perish and the new ones that will be created. This can be seen in Figure 2. With an understanding of the new job opportunities that are likely to emerge, we then identify the new types of skill sets and the level of expertise that will be needed in the workforce.

The visual mapping in Figure 2 shows that in the value chain of EVs, new employment opportunities are likely in the construction and management of the charging and swapping infrastructure outlets. This will also lead to a rise in entrepreneurship opportunities. The next area of opportunity is in electricity generation through renewables, transmission and distribution, vehicle-to-grid connectivity, which will require labour force.

Another new area of employment that is likely to emerge will be in the end-of-life management of vehicles – i.e recycling of batteries to extract minerals such as lithium, managing electronic waste etc. At present more of these jobs exist in the informal sector (e.g. scrap dealers) than in formal sector (e.g. e-waste recycling units). However, there are also opportunities in preparing retired batteries to serve a second life as stationery power storage systems. Other prospective jobs in vehicle and component making will include assembling battery cells into packs, and manufacturing electric motors, other components, and power electronics - provided the logistical costs of rare-earth metals don't supersede the production costs.

A few manufacturers are making EVs in India already. As production ramps up, the traditional assembly line jobs that prevailed in ICE vehicles will change because, as opposed to ICEs, manufacturing electric vehicles needs a combination of electrical, electronic and mechanical design skills. However, with skill adaptation at least some of these jobs can be saved. Point to note is that jobs in vehicle maintenance and service will substantially reduce in the case of EVs. While this will impact formal players such as brand authorised service stations, the impact will be even greater in the informal sector. Informal mom and pop shops providing vehicle repair services will not have the resources or awareness to invest in the new skills required. Typically, the value chain of EVs also creates jobs in raw material extraction and refining needed for making cells and battery packs. However, since India doesn't have many of the primary mineral reserves that can be extracted, these jobs are not likely to come to India.

Next, in the value chain of ICE vehicles, jobs in the assembly line production of vehicles can be adapted for manufacturing EVs by expanding the skill sets of the workers. As vehicles switch from crude-oil based products as their primary fuel to electricity, jobs in fuel extraction and refining will reduce. Similarly, jobs done at fuel stations will no longer be useful, unless owners of fuel stations become charging stations providers. The existing vehicle scrapping businesses will also need to quickly adapt to be able to capture the growing market of electric vehicle recycling. At present, for ICE vehicle scrapping, there are more informal players than formal ones (e.g. private companies, a few public sector enterprises) as the former has lesser regulations to follow¹¹. Similarly, jobs related to the production of the ICE powertrain (making of the engine, transmission, etc.) will gradually fade away. Table 1 summarises the job profiles and level of skill needed to contribute to the jobs that are likely to emerge from growth in demand for electric vehicles in the country.

Table 1 summarises the main occupations¹² that will emerge with the growth in electric mobility, the job duties¹³ and the level of skilling¹⁴ needed for each.

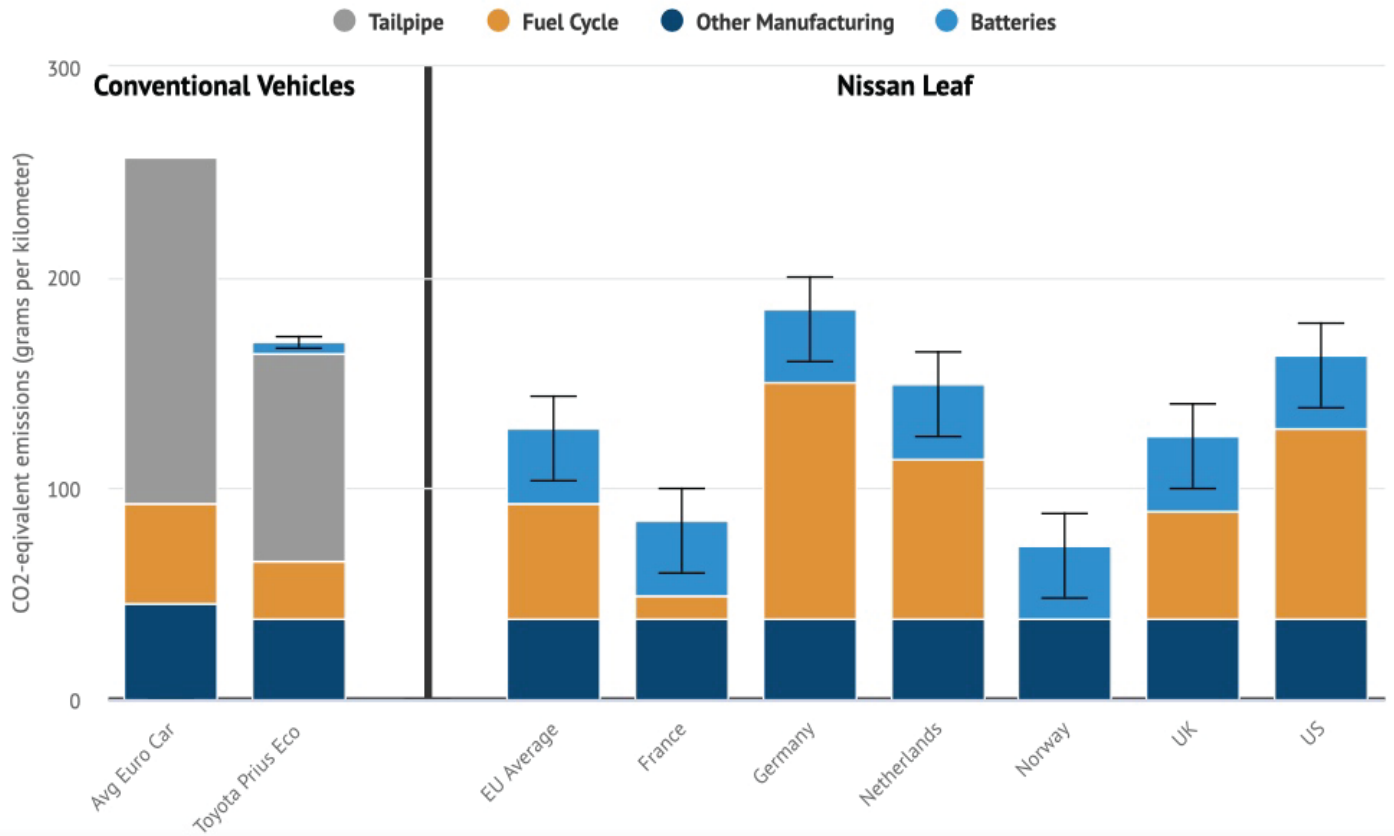
Table 1: Emerging occupations, job profiles and skilling required for EV sector

	Occupation	Job duties	Level of skilling: Skilled, Semi-skilled, Low-skilled
1)	Research and development	Chemists and material scientists	Skilled
2)	Design and development	Chemical, electronics, electrical, mechanical, material engineers; technicians and drafters, software developers and industrial designers	Skilled, Semi-skilled
3)	Manufacturing	Electrical and electronic equipment assembler, engine and machine assemblers, machinists, production managers, tool operators and final product assemblers	Skilled, Semi-skilled
4)	Vehicle maintenance	Automotive service technicians and mechanics, multi-taskers	Semi-skilled, Low-skilled
5)	Vehicle end of life	Technicians, scrap collectors and segregators	Semi-skilled, Low-skilled
6)	Fleet services	Operators, dispatch, planners, drivers, technicians, accountants	Semi-skilled, Low-skilled
7)	Sales and support	Retail persons, customer support representatives and auto dealers	Semi-skilled, Low-skilled
8)	Energy suppliers and retailers	Staff at battery swapping and charging outlets	Semi-skilled
9)	Infrastructure developers	City and regional planners, electrical power line installers and repairers, electricians	Skilled, Semi-skilled

Way forward: Preemptive planning to win jobs and create a strong EV workforce

India is clear on its intent to push electric vehicles and therefore, now is the time to plan for preparing a globally competitive labour market that is trained to make EVs in the country. Emphasis should be laid on raising awareness on the importance of skilling. This is especially critical given the large number of jobs held by Tier 2 and 3 and informal players in the automotive value chain in India. Public agencies and industry will need to join forces to create customised programmes to upskill and re-skill the existing workforce and subsequently set the agenda for higher education in the country.

Lifecycle greenhouse gas emissions: conventional v Nissan Leaf



Lifecycle greenhouse gas emissions for conventional and electric vehicles (by country) in grammes CO₂-equivalent per kilometre, assuming 150,000 kilometres driven over the vehicle lifetime. Adapted from Figure 1 in Hall and Lutsey 2018. Details of the calculations are in the methods section at the end of the article. The error bars show a range of values for emissions from battery manufacture.

Chart by Carbon Brief using Highcharts.

Source: carbonbrief.org

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