

**SAARC Energy Centre, Islamabad
Pakistan**

THE REPORT



**Webinar to Disseminate the Study on
“Infrastructure & Enabling Environment for Road Electric
Transport in SAARC Member States”**



Tuesday, May 5, 2020, Islamabad

**Organized by
SAARC Energy Centre, Islamabad**

5th May 2020

**SAARC Energy Centre
697, Street 43, Sector E-11/4 (NPF),
Islamabad, Pakistan
www.saarcenergy.org**



Introduction

SAARC Energy Centre Islamabad, under its approved Program Activities for the year 2020, successfully conducted a Webinar to Disseminate the Study on “Infrastructure and Enabling Environment for Road Electric Transport in the SAARC Member States” on Tuesday, 5th May 2020. The agenda of the webinar is available at Annexure-I.

1. The main focus of the webinar was towards dissemination of the findings and recommendations of the study to the delegates from the SAARC Member States to get their feedback and comments for value addition and further improvement of the study report. Areas discussed were: Study Approach and Methodology, Global EV Scenario and Future Growth, EV Types and Battery Technologies, EV Business Models, Key Drivers for EV Adoption in SAARC, and Country-wise Recommendations. Furthermore, China’s rapid journey towards EV and Pakistan’s current EV landscape were also discussed.

Participation

2. The webinar was attended by a total of 116 professionals representing public sector organizations, academia, private sector, and other stakeholders from within and outside the SAARC region. The Study Authors from India Smart Grid Forum and Resource Persons from China and Pakistan shared their knowledge of technologies, government policies, existing practices, and international experience in the field of Electric Vehicles. The participant’s list is available at Annexure-II.

Description

3. The webinar started with welcome remarks by Program Coordinator, Mr. Muhammad Umar Mukhtar, from SAARC Energy Centre. The technical session comprised of presentations by the Resource Persons. Each presentation was followed by a brief Q&A session. The program coordinator read-out conclusions, which were gathered during the webinar. Before closing the webinar, the Program Coordinator from SAARC Energy Centre offered remarks of appreciation to all the participants and Resource Persons.

Technical Proceedings

4. All the presentations delivered during the webinar are available at SEC's website www.saarcenergy.org. The list of Resource Persons / Experts is available at Annexure-III and presentations made by them at Annexure-IV. Brief information about each delivered presentation is as follows:

Presentation 1 – Introduction to the Study and ISGF

Mr. Reji Kumar Pillai, President India Smart Grid Forum & Ms. Reena Suri, Executive Director ISGF

5. Mr. Pillai is a well-known name in India with regards to smart grids and electric vehicles and advises the Government of India on EV policies. Being the Team Lead of the study author team, he started the technical proceedings by providing a brief introduction to the study, including its aims, objectives, and key areas of focus. He, along with fellow colleague Ms. Reena Suri also introduced the credentials of India Smart Grid Forum (ISGF) to the participants, especially their past work on electric vehicles,

Presentation 2 – Study Approach, Methodology, Outcomes, & Findings

Mr. Suddhasatta Kundu, Technical Manager, India Smart Grid Forum

6. Mr. Suddhasatta Kundu has vast experience in planning and developing EV projects and studies in India, and was a key part of the study team. He apprised the participants on the approach and methodology taken for the study report. Furthermore, Mr. Kundu explained the Global EV Scenario and gave a detailed technical overview of the types of EVs and the battery technologies covered in the study report. He comprehensively covered the study outcomes and presented a thorough roadmap for each SAARC Member State for adopting EVs. Finally, he concluded his presentation by explaining the Electric Vehicle Maturity Model to the participants, based on which the country-wise roadmaps and recommendations were developed.

Presentation 3 – Manufacturing of BEV: Discussion on Global Trends and Pakistan

Dr. Shakeel Sadiq Jajja, Assistant Professor, Lahore University of Management Sciences

7. Dr. Shakeel discussed the technical aspects of Electric Vehicles in detail and informed the participants of the perspectives and issues related to the manufacturing of

EVs. He presented the key components of EVs with regards to local manufacturing and comprehensively described the EV manufacturing value chain in Pakistan.

8. According to Dr. Shakeel, Pakistan's industry with regards to battery manufacturing mainly focuses on lead-acid batteries, and there is not enough focus on lithium-ion batteries. Furthermore, he informed the participants that various motor manufacturers exist in Pakistan, but they lack in motor quality and sophistication because mostly recycled and scrapped material is used for motor manufacturing. He further informed that controller manufacturing is non-existent in Pakistan, and stressed the need for universities and R&D institutes to shift their focus towards EV research.

Presentation 4 – The Road to Electrification in China

Mr. Alan Liu, CEO, GH Energy, China

9. Mr. Liu presented a comprehensive overview of China's EV revolution and informed the participants how China rapidly became a world leader in EV manufacturing and adoption. He started his presentation by describing the current situation of EVs in China and apprised the participants that around 1.2 million EVs were sold in China in 2019 alone. Mr. Liu stated that since 2014, over 200 startups in China have been developing and manufacturing EVs, and the focus is now on integrating artificial intelligence and 5G technology to develop intelligent EVs. He also described that due to China's dependence on imported oil, the government has prioritized the electrification of the transport sector through EVs.

Feedback Session and Conclusion

Mr. Muhammad Umar Mukhtar, Research Fellow (Energy, Transport & Environment), SAARC Energy Centre

10. Mr. Mukhtar moderated a feedback session for getting insights and comments from the participants with regards to the study report. The participants did not have any specific comments regarding the study; however, they were keen to ask more questions from the study authors regarding general EV topics and trending EV technologies. The participants were given the chance to openly interact with the Resource Persons and ask questions on wide-ranging topics such as charging standards, EV life cycle impact, technology localization, Pakistan EV policy, EV maturity model, and the longest distance covered by EVs in India. At the end of the session, Mr. Mukhtar thanked everyone for their active participation in the session. He informed the participants that the draft study report has been uploaded on the SEC website, and requested them to go through the study report to share study-related feedback and comments in the email.

Closing of Webinar

Mr. Muhammad Umar Mukhtar, Research Fellow (Energy, Transport & Environment), SAARC Energy Centre

11. Mr. Muhammad Umar Mukhtar informed all the participants that the presentations will be available on SAARC Energy Centre's website (www.saarcenergy.org). He requested the participants to submit suggestions and comments to the SEC for any further improvement to the study report. He informed the participants that they may also suggest and submit any topics of their interest to the SEC for arranging future webinars. He closed the webinar with a thank you note to everyone attending the Webinar.

12. All the presentations delivered during the webinar are available at SEC's website www.saarcenergy.org.

Annexures

Webinar Agenda

Webinar to Disseminate the Study on “Infrastructure and Enabling Environment for Road Electric Transport in SAARC Member States”

Tuesday, 5th February 2020

1100 – 1105	Introduction
1105 – 1125	Introduction to the Study and ISGF <i>Presenter: Mr. Reji Kumar Pillai (President – India Smart Grid Forum)</i>
1125 – 1145	Approach and Methodology of the Study <i>Presenter: Mr. Suddhasatta Kundu (Technical Manager – ISGF)</i>
1145 – 1150	Q & A session
1150 – 1225	Study Outcomes, Findings, and Recommendations <i>Presenter: Mr. Suddhasatta Kundu (Technical Manager – ISGF)</i>
1225 – 1230	Q & A session
1230 – 1245	Study Report Feedback Session <i>Moderator: Mr. Muhammad Umar Mukhtar – RF(ETE) SAARC Energy Center</i>
1245 – 1305	Manufacturing of BEVs: Discussion on Global Trends and Pakistan <i>Presenter: Dr. Shakeel Sadiq Jajja (Assistant Professor – LUMS)</i>
1305 – 1310	Q & A session
1310 – 1330	The Road to Electrification in China <i>Presenter: Mr. Alan Liu (CEO – GH Energy)</i>
1330 – 1335	Q & A session
1335 – 1345	Summarizing Conclusions and Recommendations of Webinar
1345	Closing of Webinar

Information for the participants:

1. All times mentioned in the agenda are according to Pakistan Standard Time (PKT). The participants from the other Member States may attend Webinar by following their own national time. The time conversion for all Member States is given below for reference:

Country	Afghanistan	Bangladesh	Bhutan	India	Maldives	Nepal	Sri Lanka
Local time	(PKT-00:30)	(PKT+01:00)	(PKT+01:00)	(PKT+00:30)	PKT	(PKT+00:45)	(PKT+00:30)

2. The participants can ask questions to presenters by typing questions or clicking to the raised hand option into the Attendees pane of the main window of GotoWebinar software. You may send in your questions at any time during the presentations; we will collect these and address them during the Q&A session at the end of each presentation.
3. All participants can also submit comments/views and/or observations on a webinar to SAARC Energy Centre through email to Mr. Muhammad Umar Mukhtar, Research Fellow (ETE) (rfete@saarcenergy.org) by 12th May 2020.

List of Participants

S. No.	First Name	Last Name	Email address
1	Rabnawaz	Anjum	rabnawaz.anjum@kapco.com.pk
2	Muhammad Asad	Malik	asad.malik@gil.com.pk
3	Hafsa	Chohan	hafsa.qayyum96@gmail.com
4	Ugyen	Yoezr	ugyen.dhps@gmail.com
5	Mujtaba	Yaqoob	mujtabayaqoob@yahoo.com
6	Muhammad Ali	Qureshi	m.qureshi2@unido.org
7	Stuart	Zhang	sanping.zhang@siemens.com
8	Arshad	Bajwa	afbajwa@gmail.com
9	Jamil	Masud	jamil.masud@sepproject.com
10	Ashraf Hossain	Bhuiyan	ahossain@idcol.org
11	Balasubramanyam	Karnam	bala.k@indiasmartgrid.org
12	Hussni Mubrak	Azizi	Hussni.azizi@gmail.com
13	Amar	uddin	amaruddin4@gmail.com
14	Dibya	Adhikari	dibyaadhikari33@gmail.com
15	Dr Fatima	Alvi	fatimaalvi2007@gmail.com
16	Umer	Younis	umer.younis@hotmail.com
17	Aminath Maiha	Hameed	aminath.maiha@environment.gov.mv
18	Fakhar	Alam	fakhar2879@gmail.com
19	Junaid	Khan	tojunaid@gmail.com
20	Hassan	Zaidi	hassan.zaidi@totalparco.com.pk
21	Abid	Latif	abid.latif@totalparco.com.pk
22	Nirmal	Paudel	nirmal323@gmail.com
23	Tula	poudel	rfet@saarcenergy.org
24	Abdullah	Salaam	abdullah.salaam@live.com
25	Humairah	Jabeen	humairah_jabeen@hotmail.com
26	Munal	Akhtar	munalakhtar@yahoo.com
27	Pratik	Karki	pratikkarki77@gmail.com
28	Tahir	Iqbal	tahirse6393@gmail.com
29	Farrukh	Iqbal	dgun@mofa.gov.pk

S. No.	First Name	Last Name	Email address
30	Ali Waqas	Malik	dr.dr.aliwaqas@gmail.com
31	Hasibullah	Qazizada	hasibullahqazizada7.5@gmail.com
32	SAYAK	MULLICK	sayak5648@gmail.com
33	Ritwik	Ray Chaudhuri	ritwik.raychaudhuri96@gmail.com
34	Muhammad Khayyam	Ilyas	khayyam.ilyas@gmail.com
35	Imran Ali	Shah	coaltechnology@gmail.com
36	Aayush	Anand	aayushanandpathak@gmail.com
37	Alan	Llu	lchskqhbd@hotmail.com
38	Mir	Muhammad	mir.mangi@gmail.com
39	Jahanzeb	Hassan	jahanzeb.rsl@gmail.com
40	Sujan	Adhikari	adhikariisujan@gmail.com
41	Mehnaz	Gardezi	cs@saarcenergy.org
42	Muhammad Adnan	Arshad	madnan_arshad@hotmail.com
43	shoaib	ahmad	ddcoord@saarcenergy.org
44	Kush	Lohana	kushlohana1998@gmail.com
45	Ihsan	Marwat	rfee@saarcenergy.org
46	Subash	Panta	subpan.kha@gmail.com
47	Junaid	Ahmed	junaid0235@gmail.com
48	Muhammed Khalil	Anjum	khalilanjum350@gmail.com
49	Farman	Marwat	acctt.asstt@saarcenergy.org
50	Muhammad	Awais	admin.asstt@saarcenergy.org
51	Owais	Khan	19060025@lums.edu.pk
52	Wania	Rafi	wania.rafi@ke.com
53	Anam	Iqbal	anam.iqbal@lums.edu.pk
54	Buland	Siddiqui	buland.siddiqui@sepproject.com
55	nauman	hussain	sfo@saarcenergy.org
56	Mohammad Abubakr	Javed	abubakr.javed@lums.edu.pk
57	Saad	Latif	saad.latif@ke.com.pk
58	Malik	Faizan	malik.faizan@lums.edu.pk
59	Aijaz	Ahmed	aijsiddiqi@yahoo.com
60	Arif	Goheer	arifgoheer@gmail.com

S. No.	First Name	Last Name	Email address
61	Sidra	Farooqi	sidra_farooqii@hotmail.com
62	Ali Hussain Umar	Bhatti	alihussain_95@outlook.com
63	Kifayatullah	Kalhor	electronics_engineer91@yahoo.com
64	Engr Gulzar Ahmed	Memon	engrgulzarmemon@hotmail.com
65	Akbar	Yusuf	Akbar.Yusuf@sepproject.com
66	Iram	Shahzadi	iramrvc@gmail.com
67	Malik	Arslan	malik.arslan@lums.edu.pk
68	Mehak	Masood	mehakmasood@gmail.com
69	Muhammad	Muzzamil	mohammadmuzzamil@hotmail.com
70	Sarfaraz	khan	sarfaraz.npo@gmail.com
71	Ali	Khan	ali.khan@akla.com.pk
72	Ahsan	Zaheer	18020324@lums.edu.pk
73	Ali	Husnain	ali.husnain@wwindea-pk.org
74	Donald	McCubbin	dmccubbin@usaid.gov
75	Imran	Ahmed	engr_imran.ahmed@yahoo.com
76	Tasneem	Chowdhrey	tchowdhrey@hotmail.com
77	Mohammad Arham	Sohail	mohammad.sohail@lums.edu.pk
78	Naveed	Arshad	naveedarshad@lums.edu.pk
79	Muhammad Huzaifa	Qasmi	huzaifaqasmi2011@gmail.com
80	Muhammad Usman	Tahir	musmantahir16@gmail.com
81	Sultan	Khan	sfakhan@meconsultonline.com
82	Ahmad	Talha	rftt@saarcenergy.org
83	Naveed	Qureshi	qnaveed777@gmail.com
84	Sana	Qayum	sanaaqayum@gmail.com
85	Farhana	Chowdhury	solartielt@gmail.com
86	Bhaskar	Pradhan	plet@saarcenergy.org
87	Prashanthi	Narangoda	director@saarcculture.org
88	Nimal	Perera	nimal_pr@sltnet.lk
89	Laveet	Kumar	laveet.kumar@gmail.com
90	Gonzalo	Duran	ceo@aerometro.org
91	Faisal	Abbas	faisalabbas4513@gmail.com

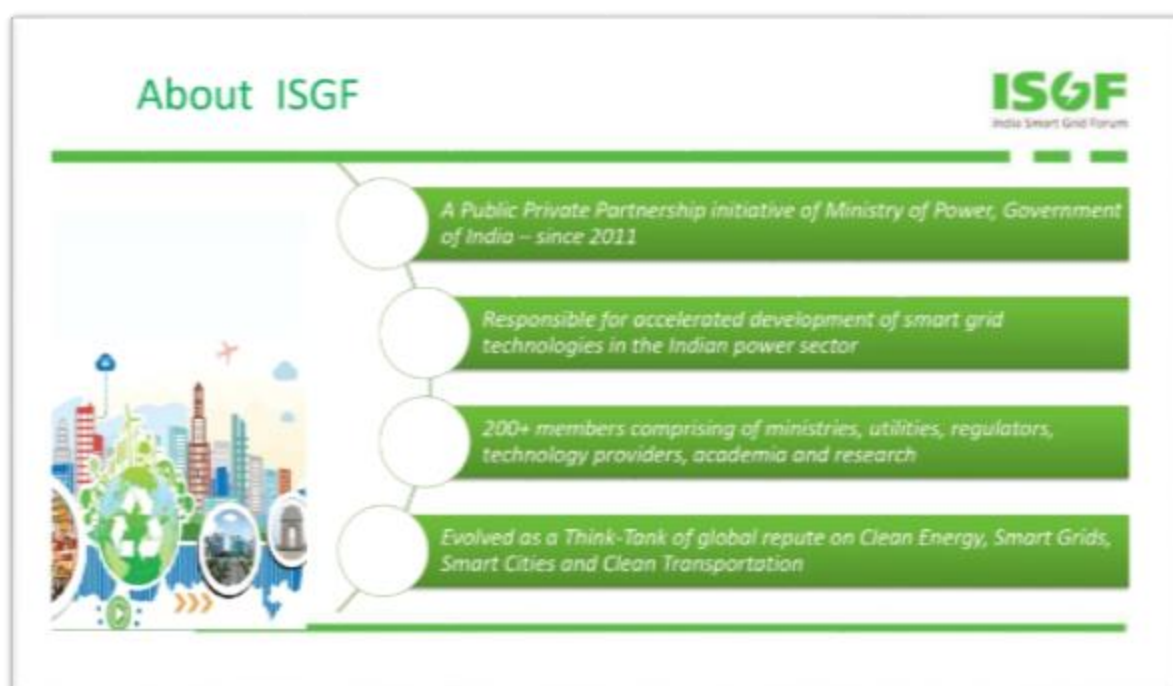
S. No.	First Name	Last Name	Email address
92	Rajesh	P	prajesh@asci.org.in
93	Abdul	Wahab	wahab.saarc@gmail.com
94	Abdul	Wahab	deo@saarcenergy.org
95	Shuvam	Sarkar Roy	shuvam@indiasmartgrid.org
96	zain ul abedin	khewa	engineerzain17@gmail.com
97	Asad	Mahmood	asadm_46@yahoo.com
98	Ki Joon Kim	Kim	kjkim@adb.org
99	Reji Kumar	Pillai	reji@rejikumar.com
100	SUDDHASATTA	KUNDU	s.kundu@indiasmartgrid.org
101	Nazrul	Islam	epnz2009@gmail.com
102	S M Mohibur	Rahman	mohib9@gmail.com
103	Ahsan	Javed	ahsan@saarcenergy.org
104	Reena	Suri	reena.suri@indiasmartgrid.org
105	Tanvir	Ahmad	pltt@saarcenergy.org
106	pradeep	kumar	ravichandran.pradeep.kumar@pwc.com
107	Huma	Kamran	pstodirector@saarcenergy.org
108	Gopal	Basnet	yiur_gopalbasnet@yahoo.com
109	Abdallah	Baba	abdallah.baba@gmail.com
110	Saad	Zaheer	saadzaheer@gmail.com
111	Jitaditya	Dey	jitaditya.dey@pwc.com
112	Tanvir	Ahmad	tanvir.ahmad@yahoo.com
113	Bhim	gautam	journalistbhim@gmail.com
114	Tehseen	Ilahi	engineer_tehseen@yahoo.com
115	Khurram	Shabbir	khurram.shabbir@live.com
116	Mirza Itaf	Hussain	altafmirza878@gmail.com

List of Presenters/Resource Persons

S. No.	Name	Designation	Organization	Email address
1.	Mr. Reji Kumar Pillai	President	India Smart Grid Forum	reji@rejikumar.com
2.	Mr. Suddhasatta Kundu	Technical Manager	India Smart Grid Forum	s.kundu@indiasmartgrid.org
3.	Ms. Reena Suri	Executive Director	India Smart Grid Forum	Reena.suri@indiasmartgrid.org
4.	Dr. Shakeel Sadiq Jajja	Assistant Professor	Lahore University of Management Sciences	ssj@lums.edu.pk
5.	Mr. Alan Liu	CEO	GH Energy	alanliu@ghed.com.cn

Presentations Delivered During the Webinar

1. “Study on Infrastructure and Enabling Environment for Road Electric Transport in the SAARC Member States” by Mr. Reji Kumar Pillai, Ms. Reena Suri and Mr. Suddhasatta Kundu (ISGF)



ISGF Credentials on E-Mobility



- Development of implementation roadmap for electrification of public transportation in Kolkata
- Establishment of charging stations for deployment of 80 electric buses (FAME- I) in Kolkata
- Advisory Services on scaling up of electric mobility deployment for the Transport Department of West Bengal, India
- Study on Infrastructure and Enabling Environment for Road Electric Transport in SAARC Member States
- Feasibility study on introduction of electric vehicles in the Sundarbans mangroves with special focus on the forest fringe parts of Indian Sundarbans
- Detailed Planning Studies for installation of Electric Vehicle Charging Stations and network upgradation in Bangalore City (on going)
- Preparation of proposal for Alfanar Energy Pvt. Ltd., Saudi Arabia for allotment of Charging Stations under Fame II Scheme in Cities
- Active participation and contribution in BIS ETD-51 Committee for preparation of Indian standards for EV Charging Infrastructure (IS:17017 series)
- Advised/ Advising several states on formulation of EV Policies (Karnataka, Kerala and West Bengal)

ISGF Credentials on E-Mobility



- Worked with Forum of Regulators (FOR) and several State Electricity Regulatory Commissions for creation of separate electricity tariff slab for EV charging – presently 16 states have special EV tariff
- Conducted a series of brainstorming sessions with different stakeholders and submitted the recommendations to Ministry of Power (MoP), based on which MoP issued order clarifying that EV Charging Business does not require separate license
- Published following White Papers:
 - Electric Vehicle Charging Stations Business Models in India (2018)
 - Electric Vehicle Policies and Electricity Tariff for EV charging in India (2019)
 - Electric Vehicles: A Sustainable Solution for Air Pollution in Delhi (2016)
 - Policy Framework for Electric Rickshaws in Delhi (2014)

ISGF Credentials on Smart Grids, RE etc



- Smart Grid Vision and Roadmap for India (2013)
- Assisted Ministry of Power, Govt. of India in preparation of the Framework for National Smart Grid Mission (2014)
- Smart Grid Roadmap for Perusahaan Listrik Negara (PLN), Indonesia (2019)
- Smart Grid Roadmap for Bangalore Electricity Supply Company (2017-18)
- Development of Roadmap for Smart Grid-Concepts, Practices and Technologies in SAARC Region (2018)
- Energy Storage System Roadmap for India (2019)
- Peer to Peer (P2P) Trading Platform on Blockchain Technology for Trading of Solar Power at Customer Premises in Uttar Pradesh, India (on going)
- Designing of Time of Use Electricity Tariff in the State of Gujarat (on going)
- Smart Grid Handbook for Regulators and Policy Makers (2017)
- AMI Rollout Strategy and Cost Benefit Analysis in India (2016)
- Next Generation Smart Metering – IP Metering (2016)
- Undertook Cyber Security Preparedness Survey of Utilities and prepared Cyber Security Manual for Electric Utilities in collaboration with National Critical Information Infrastructure Protection Center (NCIIPC)

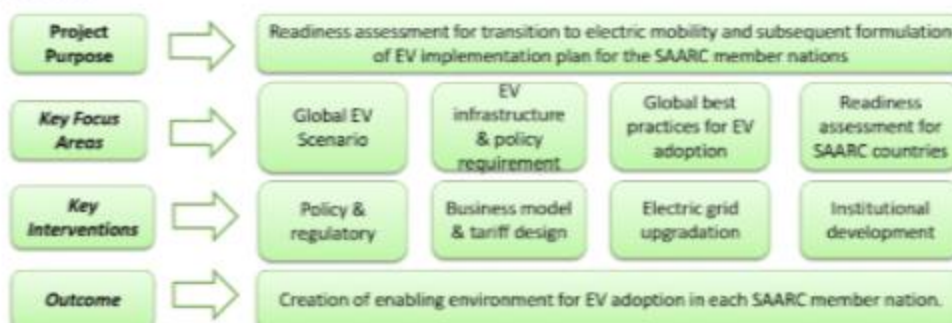


Study on Infrastructure and Enabling Environment for Road Electric Transport in SAARC Member States

Project Brief and Objectives



- SAARC Energy Centre has been awarded the project *"Study on Infrastructure and Enabling Environment for Road Electric Transport in SAARC Member States"* to India Smart Grid Forum on 1st June 2018.



7

Approach and Methodology



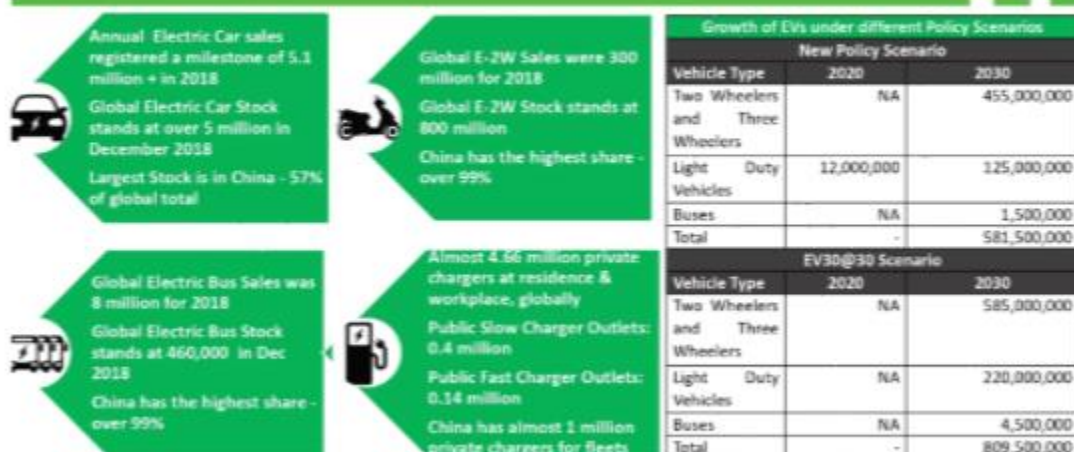
Electric Vehicle Maturity Model (EVMM) framework has been used for preparing the Electric Vehicle roadmap for the SAARC countries. Details about EVMM process is explained in slides #40-#41

8

Global Electric Vehicle Scenario

9

Global EV Stock and Future Growth



10

Types of EV

Technology/Protocol	BEV	HEV	PHEV	FCEV
Propulsion	Electric Motor	ICE/ Electric Motor	ICE/ Electric Motor	Electric Motor
Battery Charging	Plug-in	Regenerative Breaking	Plug-in	Fuel Cell Energy
Fuel	Electricity	Petrol/Diesel	Petrol/Diesel/Electricity	Hydrogen
Infrastructure	Electric Charging Facilities	Refueling Stations	Refueling Stations & Electric Charging Facilities	Hydrogen Production and Transportation facilities
Tailpipe Emissions	No	Low	Low	No
Features	- High efficiency - Oil independent - Commercially available	- Low emission - Better fuel economy than ICE vehicles - Commercially available - Long range	- Low emission - Better fuel economy compared to ICE vehicles depending on motor use and driving cycle - Commercially available	- High energy efficiency - Oil independent - Under Development
Challenges	- High cost compared to ICE vehicles - Lack of charging infrastructure - Relatively short range - Battery and battery maintenance	- High cost compared to ICE vehicles - Battery sizing and management - Longer Range	- High cost compared to ICE vehicles - Battery sizing and management - Lack of charging infrastructure - Longer range compared to conventional hybrids	- Fuel Cell cost, reliability, safety - Hydrogen infrastructure

11

Existing Battery Technologies

Battery Chemistry	Maximum C Rate	Max Temperature (Degree Celsius)	Life (Maximum Cycles)	Power Density (Wh/kg for cell)	Average Module Price (US\$/kWh in 2018)
Lithium Ion Iron-Phosphate (LFP)	Up to 2C	40	1500-3000	100-130 Wh/kg	270
Lithium Ion- Nickel Manganese Cobalt (NMC)	C/2	40	1000-2000	230-250 Wh/kg (for NMC 811)	250
Lithium Ion- Nickel Manganese Cobalt (NMC)	3C	40	3000-4000	200 Wh/kg (for NMC 622)	400
Lithium Nickel Cobalt Aluminium (NCA)	2C	40	1000-1500	250-270 Wh/kg	230
Lithium Ion Titanate Oxide (LTO)	6C	60	7500-10000	50-80 Wh/kg	700

Source: (ISGF White Paper Electric Vehicle Charging Stations Business Models for India, 2018)

12

EV Business Models

ISGF
India Smart Grid Forum

I. AGGREGATOR MODEL

- Coordinator between system operator, EV owner and distribution utility
- Collates EVs and create a potential source of energy that can be used by the utilities and system operator during the periods of high demand-supply gap.

II. OWNER MODEL

- Integrate large EV fleet through individual vehicle owners who then directly participate in the energy market
- EV owner will receive signals and directly manage the requests from utilities and system operators with the help of the two-way communication and control systems. This can be achieved by optimizing charging price so that the EV owner can minimize the charging cost at all times while reducing the stresses on the power grid.

III. DISCOMS

- DISCOMs shall be the owners and operator of charging facilities under a separate deregulated model

IV. BUS DEPOTS

- STUs themselves shall be the owners and operators of charging facilities for their own buses as well as their franchisee private bus operators

V. BATTERY SWAPPING

- The battery charging could be at public facilities or at their own captive industrial establishments from where charged batteries can be delivered at strategic locations within the city

VI. FRANCHISEES AT PARKING LOTS AND MUNICIPAL FACILITIES

- Franchisees of DISCOMs will own and operate charging facilities at premises allotted by City Governments/Municipalities or leased from the landlords.

13

Electric Vehicle Key Drivers in SAARC Countries

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14

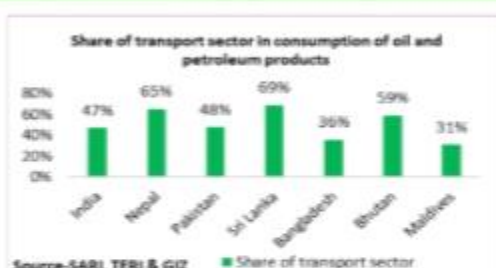
SAARC Countries: Existing Scenario



Country	Installed Power Generation Capacity (MW)	Crude Oil Imports (USD Million)	Petrol Imports (USD Million)	Diesel Imports (USD Million)	Remarks
Afghanistan	585	NA	327 (2017-18)	26.5 (2017-18)	Electricity imports of 5761 GWh from neighboring nations
Bangladesh	15,821	483 (2016-17)	3,814 (2016-17)	-	Petrol Imports include all Petroleum products
Bhutan	1,623	-	25 (2016)	82 (2016)	Electricity exports of 3372.3 MU
India	3,44,689	49,055 (April-November, 2017)	7,624 (April-November, 2017)	-	Petrol Imports include all Petroleum products
Maldives	363	-	37.4 (2011)	234.4 (2011)	-
Nepal	1,070	-	1087.5 (2016-17)	-	Petrol Imports include all Petroleum products
Pakistan	25,186	1,840.7 (2016-17)	4,846 (2016-17)	-	Petrol Imports include all Petroleum products
Sri Lanka	4,043	587.6 (2011)	-	-	-
Total	4,01,424	-	-	-	-

Sources: [SAARC Primary Findings] (Power Division of the People's Republic of Bangladesh, n.d.) (National Statistics Bureau, Royal Government of Bhutan, 2017) (Ministry of Power, Government of India, 2018) (Ministry of Environment and Energy, Republic of Maldives, 2017) (Nepal Electricity Authority, Government of Nepal, 2018) (National Electric Power Regulatory Authority, Government of Pakistan, 2017) (Ministry of Power and Renewable Energy, Government of Sri Lanka, 2017) (Annual Trade Statistics, Afghanistan, 2018) (Bangladesh Bureau of Statistics (BBS), 2017) (Ministry of Petroleum and Natural Gas, Government of India, 2017-2018) (Maldives Monetary Authority, 2017) (Economic and Social Statistics of Sri Lanka, 2018)

SAARC Countries: Transport Sector Scenario



Share of transport sector in GHG emission	
Pakistan	11%
Bangladesh	6%
Sri Lanka	16%

Source - USAID

GDP The transport sector for each SAARC country has a contribution of at least 7% in the respective GDPs	Registered Motor Vehicles - SAARC region has over 238 million registered motor vehicles - Steep increase in motor vehicles is forecasted in the near future
Primary Energy Consumption By the year 2025, the share of transport sector in primary energy consumption stood at 7%	GHG Emissions The transport sector contributes 6% to 27% of total GHG emissions for different SAARC countries

Key Recommendations of the Study

17

Afghanistan: EV Roadmap 2018-20

Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

Establishment of an EV Apex Body for Transport Planning and Policy Development

Roadmap for Incentive (RI)

- Subsidize import duty on EVs and registration on e-2W and e-3W
- Reduce property tax for charging station installation

Automotive Sector (AS)

- E-2W to be imported from India, China and Japan
- Battery and charging equipment to be imported from India and China for pilot projects

Electrical Infrastructure (EI)

- Exploitation of 300GW RE potential and power capacity augmentation by DABS for EV charging

VPRIC

RI

AS

EI

EVT

VCI

CUST

SE

EV Technology (EVT)

- Due to import of e-buses and e-3W from China and India, GB/T, CHAdeMO or CCS2 should be adopted

Value Chain Integration (VCI)

- Big business houses to use e-2W and e-4W for their own use and to set up EVSE in their areas
- Hotels, hospitals and companies to pool their CSR funds for financing of electric buses, four wheelers and charging stations on pilot basis

Customer (CUST)

- Create awareness regarding EV pilot programs and encourage the population to use e-Buses and e-3W

Social & Environmental

- Organizing EV awareness programs, conduct workshops and seminars

18

Afghanistan: EV Roadmap 2020-25

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

National EV Policy

Pilot project on e-Bus and e-3W in major cities by central and local governments and development banks

Roadmap for Incentive (RI)

Govt support for e-3W, e-Bus and taxis pilot projects

Low interest loans on e-2W and e-4W

Govt support for 3rd party charging station installation

Automotive Sector (AS)

E-Bus and e-3W for pilots to be imported from India, China and Japan. Services to be provided by OEMs for initial years.

Electrical Infrastructure (EI)

Upgradation of electrical infrastructure in bus depots and terminus, three wheeler parking spaces, etc. in major cities by DABS for installation of charging stations.

VPRIC

RI

AS

EI

EVT

VCI

CUST

SE

EV Technology (EVT)

- Retrofitting of existing three wheelers which are operating for a long time into e-3W

Value Chain Integration (VCI)

- Battery swapping model for e-3W with the help of a Battery Leasing Agency (BLA)
- DABS and Ministry of Transport to set up charging station for e-buses in bus depots

Customer (CUST)

- Govt vision on EVs communicated to customers
- Incentives and benefits for adopting e using an EV to be communicated properly to customers

Social & Environmental

- E-buses and commercial taxi fleets can also provide opportunity to the existing workforce by providing them adequate training or O&M skills

19

Afghanistan: EV Roadmap 2025-30

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

Mandated EV zones in certain city centres, government offices, embassies, major market areas

EV adoption city targets focused on public transportation by 2035

Roadmap for Incentive (RI)

Subsidized registration charges for one year for passenger cars as well as subsidies on CAPEX

Duty free import of plant and machinery for setting up of assembly unit on one time basis

Automotive Sector (AS)

Setting up small assembling units for e-2W and e-3W with foreign companies

Servicing facility for charging stations can be provided by OEMs and local capacity development

Electrical Infrastructure (EI)

Improvement in power quality through deployment of technologies like harmonic filters, static compensators

VPRIC

RI

AS

EI

EVT

VCI

CUST

SE

EV Technology (EVT)

- Govt and international research labs, technology institutes, private companies to work on optimization of lithium extraction process

Value Chain Integration (VCI)

- Pilot project charging stations should be established at prominent bus routes and areas having high 3W concentration

Customer (CUST)

- ToU pricing and its benefits to the customers must be displayed to make them aware of their benefits

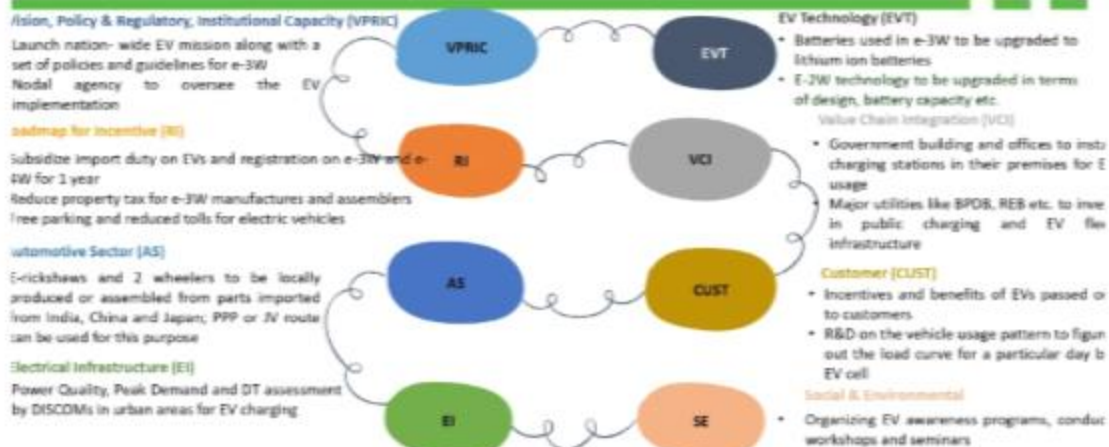
Social & Environmental

- Deployment goals by the government to help bring electricity in the remote areas

20

Bangladesh: EV Roadmap 2018-20

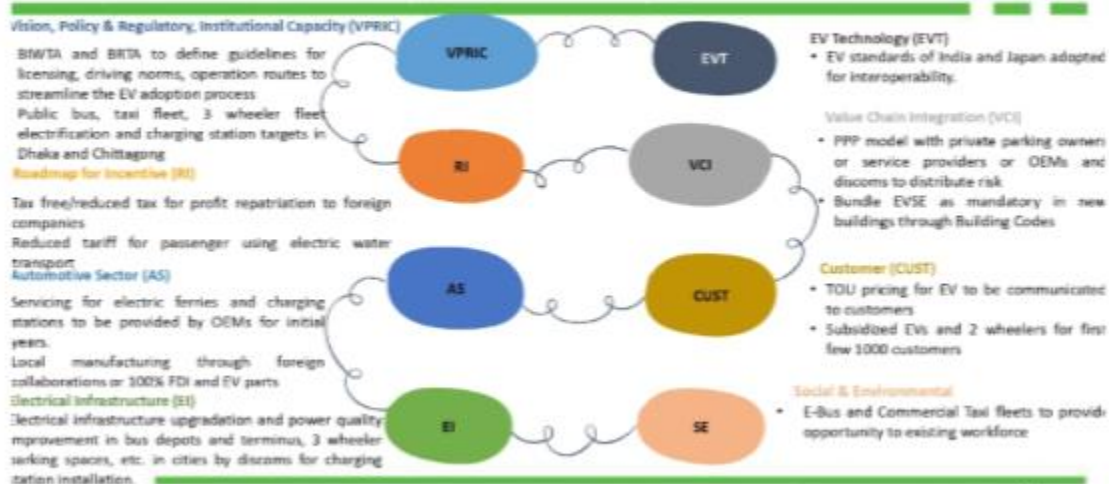
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21

Bangladesh: EV Roadmap 2020-25

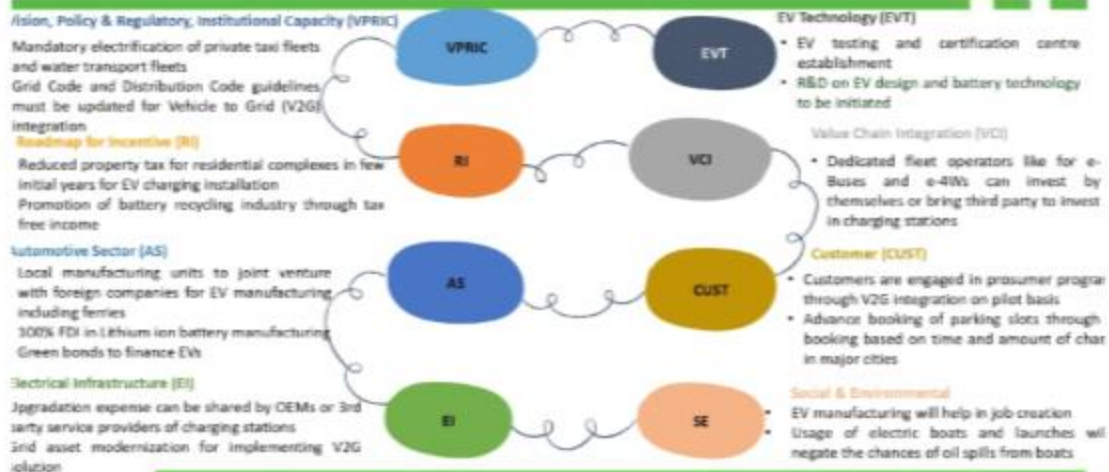
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22

Bangladesh: EV Roadmap 2025-30

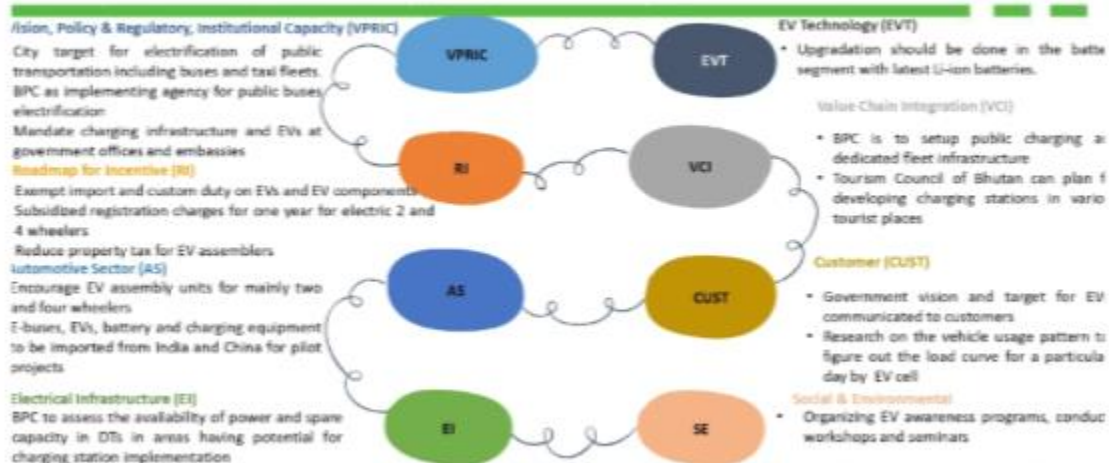
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23

Bhutan: EV Roadmap 2018-20

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24

Bhutan: EV Roadmap 2020-25

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

Subsidies on CAPEX for e-2W and e-4W
Separate EV tariff to be considered as also TOU tariff
In Thimphu, fleet operators of private taxis to be encouraged to shift to EVs through incentives

Roadmap for Incentive (RI)

Reduced electricity tariff for charging for EV charging
Reduced road tax for electric four wheeler commercial fleet
Reduced property tax for residential charging infrastructure

Automotive Sector (AS)

Servicing facilities of EVs and charging stations to be provided by DEMs

Electrical Infrastructure (EI)

Electrical infrastructure upgradation and power quality improvement in cities by BPC for charging station installation
Grid asset modernization for V2G

VPRIC

RI

AS

EI

EV Technology (EVT)

- Consider adopting EV standards of India to ensure interoperability

Value Chain Integration (VCI)

- Major cities and tourist places to prioritize the installation of charging stations in parking lots, urban centre markets, tourist spots etc.
- Mandatory for the JV hydropower project companies to develop public charging stations

Customer (CUST)

- TOU pricing for EV to be communicated to customers
- Incentives and benefits passed onto EV users

Social & Environmental

- EV deployment mainly buses and commercial taxi fleets can also provide opportunity to the existing workforce by providing them adequate training on O&M skills

VCI

CUST

SE

25

Bhutan: EV Roadmap 2025-30

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

Guidelines for 3rd party charging stations and providing charging as a service without any kind of licensing at least for one year
Grid Code and Distribution Code guidelines must be updated for Vehicle to Grid (V2G) integration

Roadmap for Incentive (RI)

Attractive FDI policy with single window clearance, registration, tax breaks, repatriation facility etc.
Bulk insurance at concessional rate for commercial fleets

Automotive Sector (AS)

Testing and certifying facility to be established in conjunction assembling units for EVs
Promote local manufacturing of e-2W through PPP or with foreign companies

Electrical Infrastructure (EI)

- Upgradation of electrical infrastructure
- Grid asset modernization for implementing V2G solution

VPRIC

RI

AS

EI

EV Technology (EVT)

- R&D on EV design to be initiated in collaboration with technology institutes, research labs, industries etc.

Value Chain Integration (VCI)

- Bundle EVSE as mandatory in new buildings through Building Codes
- Dedicated fleet operators like for e-Buses and e-4Ws can invest by themselves or bring third party to invest in charging stations

Customer (CUST)

- Customers are engaged in prosumer program through V2G integration on pilot basis
- Advanced services for customers like door door service for car charging

Social & Environmental

- 3rd party service providing of charging station will lead to job creation and people

VCI

CUST

SE

26

India: EV Roadmap 2018-20

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

Mandate charging infrastructure and EVs at government offices and embassies
National E-Mobility Programme that uses the demand aggregation model, should be expanded

Roadmap for Incentive (RI)

GST rate should be rationalized on EVs and EV components
Reduced fare for e-bus users; Reduced EV charging tariff

Automotive Sector (AS)

Local manufacturing of EVSE, EVs and batteries through JVs with companies in Europe, China, Japan
In house development of motors and power electronic equipment used for EVSE and EV

Electrical Infrastructure (EI)

Discoms to assess the availability of spare capacity in D/S
Upgradation of electrical infrastructure for charging station installation

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EI

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EV Technology (EVT)

- Retrofitting of the older EV models with new technology
- Develop custom charging connector and communication protocol

Value Chain Integration (VCI)

- Government building and offices to electrify their vehicles and install charging stations at their premises.
- Discoms and MORTH to setup e-bus charge at depots and terminuses

Customer (CUST)

- Government vision and target for EVs as well as TOU pricing benefit communicated to customers
- Research on the vehicle usage pattern to figure out the load curve for a particular day by E cell

Social & Environmental

- Organizing EV awareness programs, conduct workshops and seminars focussed on its benefits

27

India: EV Roadmap 2020-25

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

Public transport electrification - Smart City Mission
Grid Code and Distribution Code guidelines to add V2G
Building code revision: Charging infra mandated

Roadmap for Incentive (RI)

Reduced tax on profit repatriation
Subsidized registration charges for 1-2 years for 3 wheelers. Road and toll tax exemption for electric buses. Subsidized parking charges for electric cars.

Automotive Sector (AS)

Servicing facilities of electric vehicles and charging stations to be provided by OEMs

Electrical Infrastructure (EI)

Upgradation expense shared by OEMs or 3rd party service providers of charging stations
Implementation of charging stations by supermarkets, big retailers with electrical network upgradation at own cost.

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EV Technology (EVT)

- Enhancement of the charging standards and communication protocols being used

Value Chain Integration (VCI)

- State Transport Authorities to install charging stations on ferry ghats for boats
- PPP model with private parking owners, service providers or OEMs and discoms to distribute risk
- Pilot projects for water transport fleet electrification

Customer (CUST)

- Advance booking of parking slots through booking based on time and amount of charge required by the individual
- Incentives and benefits of EVs passed on customers

Social & Environmental

- E-2W and E-3W manufacturing and assembling plants will help in job creation

28

India: EV Roadmap 2025-30

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)
Government to make mandatory full electrification of public bus fleets in metro cities and tier-1 and tier-2 cities and that of private taxi fleets throughout the country.
Government to provide guidelines of battery recycling

Roadmap for Incentive (RI)

Road and toll tax exemption for commercial electric taxi fleets.

Promote battery recycling industry through tax free income or reduced interest on loans for JVs

Automotive Sector (AS)

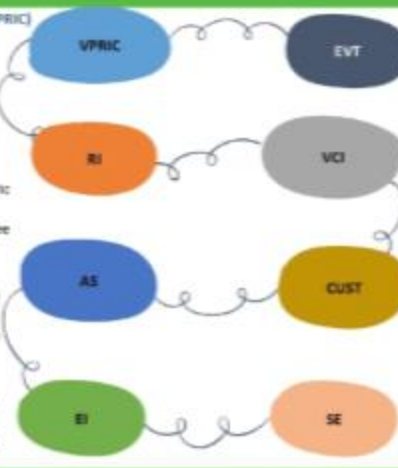
Battery manufacturing through 100% FDI and JV with local companies

Battery recycling industry to be established with foreign collaborations

Electrical Infrastructure (EI)

Facilitate EV owners to participate in demand response programs

Grid asset modernization for implementing V2G solution



EV Technology (EVT)

- R&D on battery and battery recycling

Value Chain Integration (VCI)

- Bundle EVSE as mandatory in new building through Building Codes
- Dedicated fleet operators like for e-Buses an e-4Ws can invest by themselves or bring this party to invest in charging stations

Customer (CUST)

- Customers are engaged in prosumer program through V2G integration on pilot basis
- Advanced services for customers like door to door service for car charging

Social & Environmental

- Usage of electric boats and launches will negate the chances of oil spills from boats and facilitate in reducing water pollution

29

Maldives: EV Roadmap 2018-20

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)
MEE, MED and MTA to launch nation-wide EV mission with a set of policies
Govt to discuss with banks for low cost loans for E-ZWs in the initial years or can provide subsidy on CAPEX

Roadmap for Incentive (RI)

Exempt import and custom duty on EVs and EV components

Reduced property tax for hotels & resorts using electric vehicle or electric boats

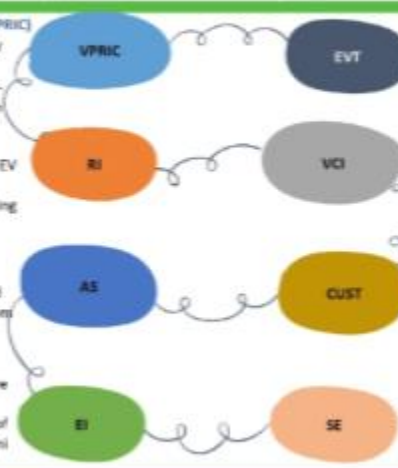
Reduced electricity tariff for charging

Automotive Sector (AS)

EV Testing and Certification Centre to be established
Battery and charging stations to be imported from countries like China for the pilot projects

Electrical Infrastructure (EI)

Discom to assess the availability of power and spare capacity in DIs
DISCOMs should assess the possibility of incorporating charging stations in the existing mini and micro grids



EV Technology (EVT)

- Technology for E-ZWs to be upgraded in term of design, battery capacity etc.
- Maldives can adopt CCS, CHAdeMo and Indis charging standards

Value Chain Integration (VCI)

- Government building and offices to electrify their vehicles and install charging stations in their premises
- Resorts and hotels can use EV and electric boats for tourist transportation and can install charging station in their premises

Customer (CUST)

- All incentives and benefits for adopting or using an EV to be communicated properly to customers

Social & Environmental

- Organizing EV awareness programs, conduct workshops and seminars

30

Maldives: EV Roadmap 2020-25

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

Mandate the use of electric two and four wheelers for vehicle rental companies, resorts and hotels
Building code revision: Charging Infra mandated in Male

Roadmap for Incentive (RI)

Reduced anchorage fee and taxes for electric yacht
Subsidy or low interest loan from banks for small fishermen for purchasing electric boats

Automotive Sector (AS)

Assembling units for EVs and e-boats mainly to be set up on JV model with foreign companies
Local manufacturing of EV like by ILAA Maldives Pvt. Ltd promoted by providing land, water and import logistic facility for manufacturing at a reasonable cost

Electrical Infrastructure (EI)

Power quality improvement
Upgradation of electrical infrastructure for charging stations

VPRIC

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CUST

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EV Technology (EVT)

- EV two & four wheeler testing and certification center to be developed.
- R&D on EV design to be initiated in collaboration with international research labs, technology institutes, etc.

Value Chain Integration (VCI)

- Bundle EVSE as mandatory in new building through Building Codes
- RE projects or micro or mini grid projects : install charging infrastructure in premises

Customer (CUST)

- Time of use pricing and its benefits to customers must be displayed to make them aware of their benefits

Social & Environmental

- EV deployment will provide opportunity to train existing workforce
- Tourism will flourish by projecting areas : carbon neutral with EV being the only transport mechanism

31

Maldives: EV Roadmap 2025-30

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

Mandate electrification of yacht, boats, fishing boats, four wheelers and launches used for public transportation

Streamline 3rd party charging process through guidelines

Roadmap for Incentive (RI)

Duty free import of plant and machinery for setting up of manufacturing or assembly unit on one time basis

Reduced property tax for EV manufacturers and assembly units

Automotive Sector (AS)

Promote local manufacturing of e-2W or yacht and boats through PPP or joint ventures with foreign companies

Servicing facility for charging stations can be provided by OEMs

Electrical Infrastructure (EI)

Implementation of charging stations by supermarkets, big retailers with electrical network upgradation at own cost

Grid asset modernization for implementing V2G solution

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EV Technology (EVT)

- MEA, technocrats and EV associations etc. to decide on the interoperability of charging and enhance the charging standards and communication protocols

Value Chain Integration (VCI)

- Private parking owners or service providers can implement public charging stations along with distribution utilities
- Fishing companies to use electric trawlers and boats and can install charging stations for a specified fee

Customer (CUST)

- Customers are engaged in prosumer program through V2G integration on pilot basis
- Advance booking of parking slots through i booking in Male based on time and amount : charge required

Social & Environmental

- E-2Ws, cars and boats manufacturing at assembling plants will create jobs

32

Nepal: EV Roadmap 2018-20



Vision, Policy & Regulatory, Institutional Capacity (VPRIC)
Govt to launch nation-wide EV mission with a set of policies and convert all 3 wheelers

MPWT to identify and dictate EV adoption target to cities with respect to public transportation including buses and three wheelers.

Roadmap for incentive (RI)

Exempt import and custom duty on EVs and EV components

Reduced electricity tariff for charging

Subsidized registration charges for one year for e-2W and e-3W

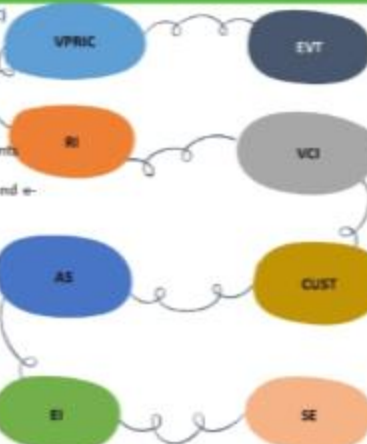
Automotive Sector (AS)

E-3Ws to be assembled with imported parts from India or China

Promote local manufacturing through PPP or with joint ventures with foreign companies like in India, Japan etc.

Electrical Infrastructure (EI)

Discom to assess the availability of power and spare capacity in DTs in areas having potential for charging station implementation



EV Technology (EVT)

- Batteries used in E-3Ws to be upgraded to lithium ion batteries
- Indian charging standards (IS:17017) may be adopted

Value Chain Integration (VCI)

- Government building and offices to elect their vehicles and install charging stations at their premises
- NEA along with DoTM to invest in charging stations for electric buses in bus depots & terminus

Customer (CUST)

- Government vision and target for EV communicated to customers. All incentives or benefits for adopting or using an EV to be communicated properly to customers

Social & Environmental

- Tourism will flourish by projecting areas carbon neutral with EVs

33

Nepal: EV Roadmap 2020-25



Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

Separate EV tariff or TOU pricing for EVs

Building codes to mandate charging facility in dedicated spaces in urban areas

Roadmap for Incentive (RI)

Reduced road tax for EVs commercial fleet

Reduced property tax for residential complexes, resorts and hotels for installing charging stations

Automotive Sector (AS)

Servicing facility for charging stations to be provided by OEMs. 100% local manufacturing units

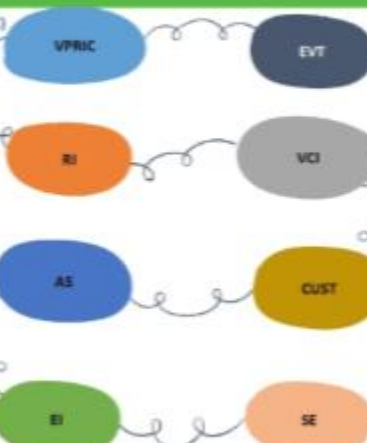
to be promoted for e-2W and e-3W

Feasibility study for monorail in the capital

Electrical Infrastructure (EI)

Upgradation of electrical infrastructure in bus depots and terminus, parking lots, malls etc. by NEA for installation of charging stations.

Improvement in power quality



EV Technology (EVT)

- Nepal Engineering Company to enhance charging standards and communication protocols being used e.g. CCS, CHAdeMO, OCPP etc.

Value Chain Integration (VCI)

- Private parking owners or service providers to implement public charging stations along with NEA
- Travel & Tourism companies, resort owners to install public charging station

Customer (CUST)

- Time of use pricing and its benefits to customers must be displayed to make them aware of their benefits

Social & Environmental

- EV deployment will provide opportunity to train existing workforce by providing adequate training on O&M skills

34

Nepal: EV Roadmap 2025-30

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

Mandate private electric fleet electrification
Grid Code and Distribution Code guidelines to add V2G

Roadmap for Incentive (RI)

Promote battery recycling industry through tax free income in initial years or reduced interest on loans for JVs with minimum 25% stake of local companies

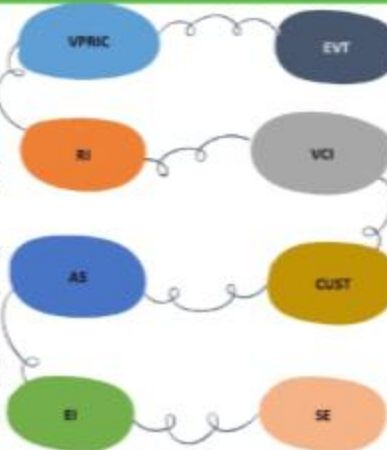
Automotive Sector (AS)

Local capacity development on O&M of charging stations through training and skill development
Charger manufacturing units to be set up with 100% FDI or through JVs with local companies

Electrical Infrastructure (EI)

Grid asset modernization for facilitating two way communication for implementing vehicle to grid solution

Electrical infrastructure upgradation for monorail implementation in Kathmandu



EV Technology (EVT)

- R&D on battery recycling to be initiated in collaboration with Nepal engineering Company, technology institutes, etc.

Value Chain Integration (VCI)

- Transition of private cars into electric fleets will provide opportunity for the retailer or third party service providers to provide door to door servicing on charging of EVs in Kathmandu

Customer (CUST)

- Customers are engaged in prosumer program through V2G integration on pilot basis
- Advanced services for customers like door to door service for car charging in Kathmandu

Social & Environmental

- Deployment goals by government will also help to bring electricity in the remote area which can help in improving the living standard

35

Pakistan: EV Roadmap 2018-20

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

MoC, MIP to launch nation-wide EV mission with a set of policies

Pilot e-bus fleet project in Karachi, Lahore, Islamabad, etc.

EV cell creation within concerned ministries.

Roadmap for Incentive (RI)

Exempt import and custom duty on EVs and EV components

Subsidized registration charges for one year for electric 2 and 3 wheelers

Reduced tariff for passengers using electric buses

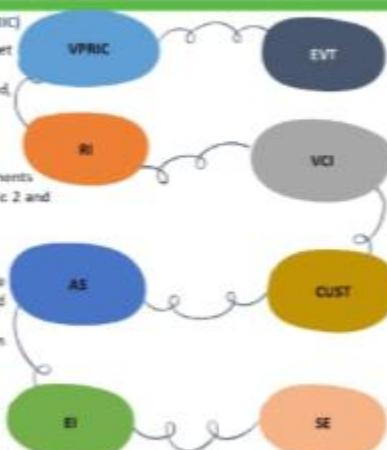
Automotive Sector (AS)

Automotive Testing and Training Center to approve the 2 wheelers and 3 wheelers being manufactured and assembled

Battery and charging stations to be imported from countries like China for the pilot projects

Electrical Infrastructure (EI)

Discoms to assess the spare capacity in Dfs, power availability and peak demand in both summer and winter season to figure out the EV demand the load network



EV Technology (EVT)

- Currently Pakistan has BMW Chargeno charging stations which follows CCS standard and as most of the vehicles are Japanese or Chinese, Pakistan can use CHAdeMO and GB charging standards.

Value Chain Integration (VCI)

- Distribution utilities and provincial transport authority to invest in charging station for e-bus in bus depots
- Big business houses to pool their CSR funds for financing of electric buses on pilot basis

Customer (CUST)

- Government vision and target for electric vehicle is communicated to customers
- Incentives and benefits to be passed onto customers

Social & Environmental

- Organizing EV awareness programs, conduct workshops and seminars to make people aware of the benefits of EV adoption

36

Pakistan: EV Roadmap 2020-25

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)
Public bus fleet electrification for intra city transfers and installation of charging stations in depots and terminus
Separate EV tariff or TOU pricing for EVs. Building codes to mandate charging facility in dedicated spaces in urban areas

Roadmap for Incentive (RI)

Reduced road tax and property tax for residential complexes, resorts and hotels for installing charging stations

Duty free import of plant and machinery for manufacturing or assembly unit

Automotive Sector (AS)

Local manufacturing units and service centers to be set up for electric 2 and 3 wheelers

Manufacturing and assembling units for electric cars and buses mainly to be set up with JV with foreign companies

Electrical Infrastructure (EI)

Upgradation of electrical infrastructure in bus depots, terminus, parking lots, malls etc. by discounts for charging infra installation

VPRIC

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EV Technology (EVT)

- Automotive testing and training center validate and certify the quality of electric vehicle manufactured
- In house development of EV technology

Value Chain Integration (VCI)

- Bundle EVSE as mandatory in new building through Building Codes
- Private bus companies to set up charging stations in their premises and can allow public charging for flat rate

Customer (CUST)

- IoU pricing and its benefits to the customer must be displayed to make them aware of the benefits
- Carry out research on the customer pattern vehicle usage

Social & Environmental

- EV deployment mainly the buses, at commercial taxi fleets can also provide opportunity to the existing workforce by providing adequate training

37

Pakistan: EV Roadmap 2025-30

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

Mandate public motor cars and jeeps electrification

Grid Code and Distribution Code guidelines to add V2G

In major cities like Karachi, Lahore, etc. private taxi fleet electrification to be incentivized

Roadmap for Incentive (RI)

Reduced property tax for EV and battery manufacturers and promote battery recycling industry through tax free income

Automotive Sector (AS)

Battery manufacturing units to be set up with JVs with foreign companies

Service facility for charging stations can be provided by OEMs and local capacity development on O&M through T&D

Electrical Infrastructure (EI)

Implementation of charging stations by supermarkets, big retailers with electrical network upgradation at own cost

Grid asset modernization for facilitating two way communication for implementing vehicle to grid solution

VPRIC

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CUST

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EV Technology (EVT)

- Pakistan Automotive Institute, technocrats, EV associations etc. to decide on the interoperability, charging standards and communication protocols
- R&D on battery and battery recycling

Value Chain Integration (VCI)

- Dedicated fleet operators like for e-Buses an e-4Ws to invest or bring 3rd party to invest in charging infra
- Private parking owners or service provider can implement public charging stations with discounts or service providers

Customer (CUST)

- Advance booking of parking slots through a booking based on time and amount of charge required by the individual in major cities like Karachi, Islamabad etc.

Social & Environmental

- Deployment goals to help bring electricity to remote areas to improve the living standard
- E-2W and e-3W manufacturing and assembling plants will help in job creation

38

Sri Lanka: EV Roadmap 2018-20

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

MoT to launch nation-wide EV mission EV policy
E-buses majorly intra city buses project in in major cities

Roadmap for Incentive (RI)

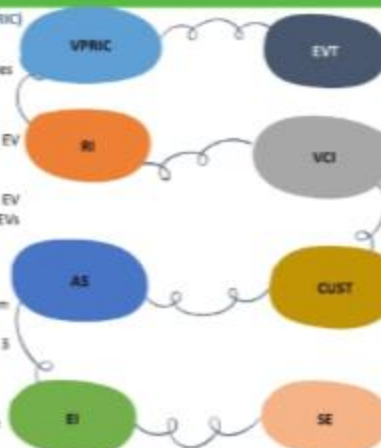
Exempt import and custom duty on EVs and EV components
Subsidized parking charges for EVs.
Reduced property tax for E-3W manufacturers, EV assembly companies and hotels and resorts using EVs and charging equipment

Automotive Sector (AS)

E-3Ws to be assembled with parts being imported from India or China
Promote local manufacturing of electric 2 and 3 wheelers through PPP or JVs with foreign companies

Electrical Infrastructure (EI)

Discoms to assess the supply and availability of spare capacity in DTs and power supply from RES



EV Technology (EVT)

- Technology for e-2W to be upgraded in terms design, battery capacity etc.
- As Sri Lanka is currently using CHAdeMO & CC it may use Indian standard

Value Chain Integration (VCI)

- CEB with SLTMB to invest in charge infrastructure for e-buses in bus depots & termini
- Private parking owner, service providers, CI LECO, mall owners or hospitals can install pub charging stations

Customer (CUST)

- Government vision, target, incentives or benefits for EV is communicated to customers
- TOU pricing and benefits communicated to customers

Social & Environmental

- Organizing EV awareness programs, condu workshops and seminar

33

Sri Lanka: EV Roadmap 2020-25

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Vision, Policy & Regulatory, Institutional Capacity (VPRIC)

Public bus fleet electrification and installation of charging stations in depots and terminus by SLTB
Electrification of public 3 wheeler fleet and inland water transport

Roadmap for Incentive (RI)

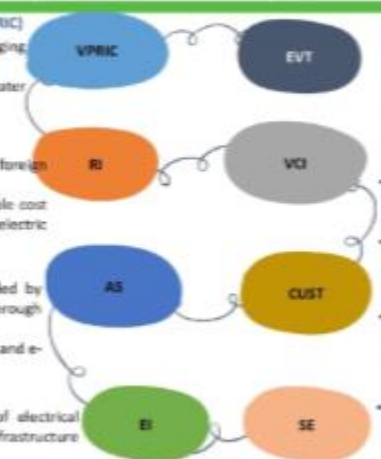
Reduced road tax for E-4W commercial fleet
Tax free or reduced tax for profit repatriation for foreign companies
Land on lease, water and logistic facility at reasonable cost for manufacturing or assembling units on EV and electric boats

Automotive Sector (AS)

Servicing facility for charging stations to be provided by OEMs and local capacity development on O&M through T&O.
100% local manufacturing units to be set up for e-2W and e-3W service centres.

Electrical Infrastructure (EI)

Upgradation and improvement in power quality of electrical infrastructure by CEB and LECO for charging infrastructure installation



EV Technology (EVT)

- PUCSL, technocrats and EV associations to enhance charging standards and communication protocols
- EV 2 & 3 wheeler testing and certification centre to be developed in Sri Lanka

Value Chain Integration (VCI)

- Transport Board along with distribution utility co set up charging stations for inland water transportation in Colombo
- Battery swapping model can be used for this wheelers with the help of a Battery Leasing Agency

Customer (CUST)

- Advance booking of parking slots through e-book based on time and amount of charge required the individual

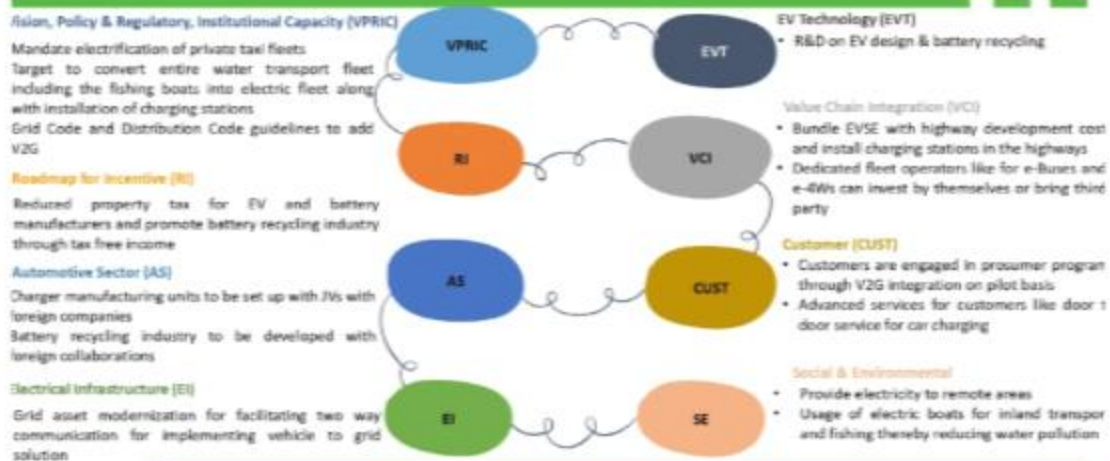
Social & Environmental

- E-2W and E-3W manufacturing and assembly plants will create jobs and people of rural are can opt for a sustainable living

40

Sri Lanka: EV Roadmap 2025-30

ISGF
India Smart Grid Forum



41

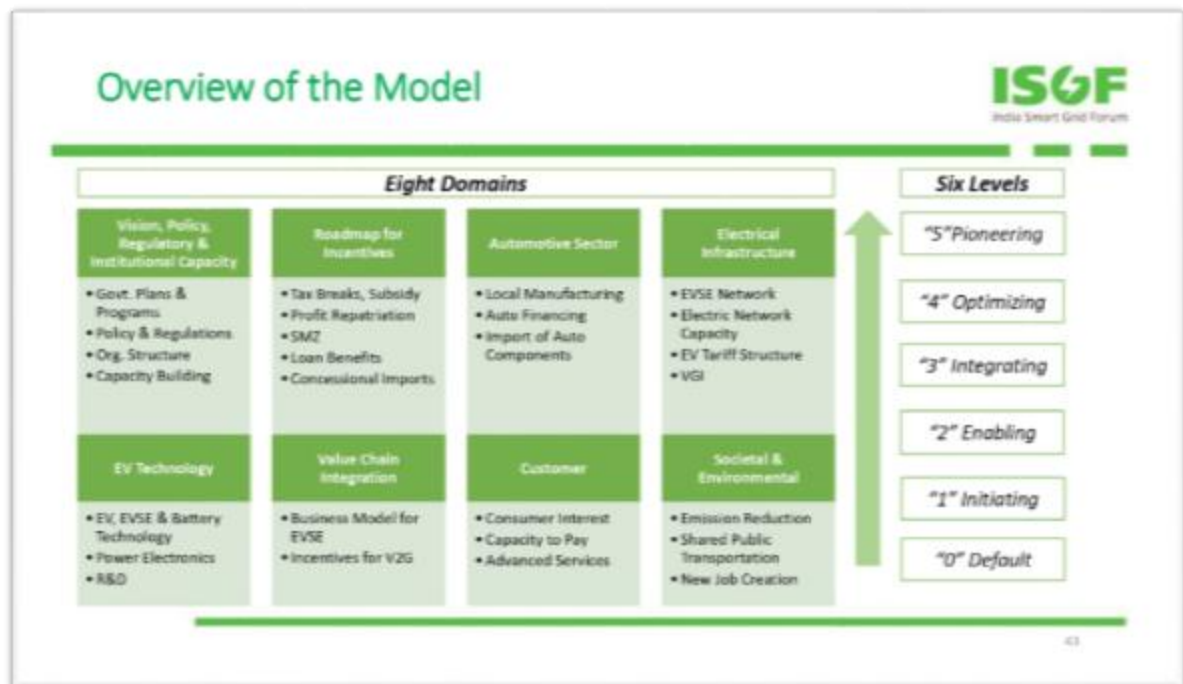
Electric Vehicle Maturity Model (EVMM)

ISGF
India Smart Grid Forum

India Smart Grid forum has developed an Electric Vehicle Maturity Model (EVMM) to assess the readiness of a Country/City for EV adoption of EVs in terms of policy, infrastructure, technology, institutional structure, market dimensions, customer acceptance etc. which will help all stakeholders including concerned Government, Public Transport Utilities, Taxi/Fleet Operators, Electric Utilities, EV and Battery Manufacturers, EVSE Service Providers etc. to identify and implement the required steps that need to be taken in a phased manner to ensure sustainable EV adoption across the country/city.

The EVMM is structured across eight domains and 6 Levels of maturity to assess the preparedness/readiness for EV rollouts and measure the progress made in each domain by the country/city.

42





India Smart Grid Forum

Thank You

India Smart Grid Forum
 CSIR Building, Malcha Marg,
 Chanakyaपुर,
 Delhi-110021
 Website: www.indiasmartgrid.org

44

2. “Manufacturing of BEVs: Discussion on Global Trends and Pakistan” by Dr. Shakeel Sadiq Jajja, Assistant Professor – LUMS

Manufacturing of Battery Electric Vehicles: Discussion on Global Trends and Pakistan

Dr. Shakeel Sadiq Jajja
Associate Professor of Operations and Supply Chain Management
Director, Executive MBA
Suleman Dawood School of Business
Lahore University of Management Sciences
Lahore, Pakistan
Email: ssj@lums.edu.pk

Dr. Shakeel Sadiq Jajja, LUMS

Overview

- Appreciating various types of electric vehicles
- Global trends in manufacturing and adoption of battery electric vehicles (BEVs)
- Manufacturing value chain of battery electric vehicles (BEVs) in Pakistan
- Future outlook in Pakistan

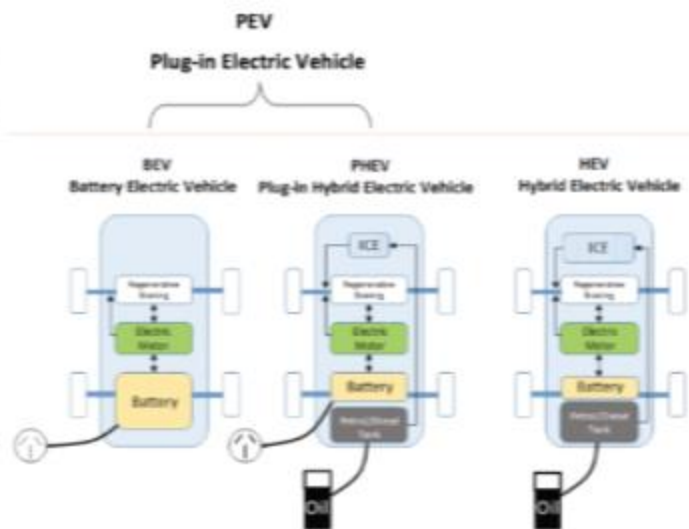
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Electric Vehicle Types

1. Battery Electric Vehicles (BEVs) or All-Electric Vehicles
2. Plug-In Hybrid Electric Vehicles (PHEVs)
3. Hybrid Electric Vehicles (HEVs)

Why is it important to differentiate?

1. Consumer standpoint
2. Infrastructure standpoint
3. Distribution and after-sale service standpoint
4. Manufacturing standpoint
5. Technological transition standpoint
6. Regulatory standpoint



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Key Components of BEVs

- Battery
 - Lithium-ion
 - Lead Acid
- Battery management system
- Motor
 - DC Series Motor
 - Brushless DC Motor
 - Permanent Magnet Synchronous Motor (PMSM)
 - Three Phase AC Induction Motors
 - Switched Reluctance Motors (SRM)
- Controller
- Cables
- Body

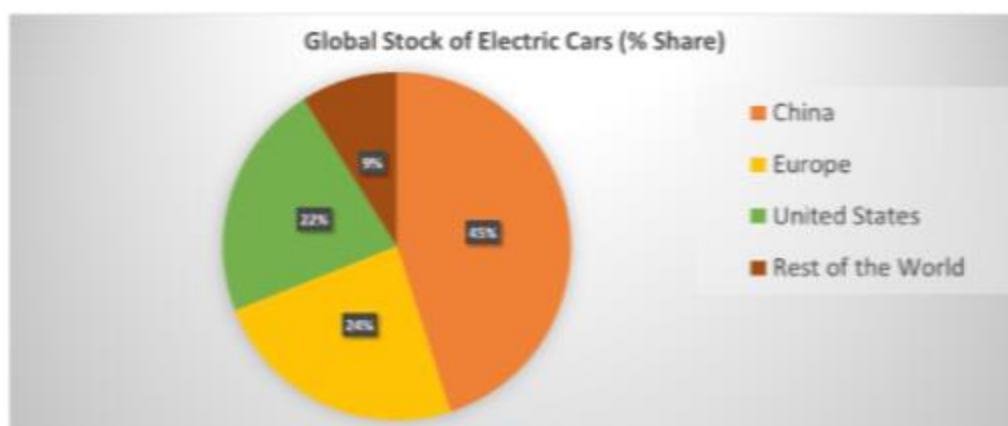
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Global Trends

- Electric mobility is expanding at a rapid pace globally.
- In 2018, the global electric car fleet exceeded 5.1 million, up 2 million from the previous year and almost doubling the number of new electric car sales.
- Battery electric vehicles (BEVs) account for 64% of the world's electric car fleet
- The People's Republic of China remains the world's largest electric car market, followed by Europe and the United States.
- Norway is the global leader in terms of electric car market share
- Vision 30 @ 30 – Aims to reach 30% EV market share by 2030. Signatories: China, Japan, Finland, France, Netherlands and Sweden

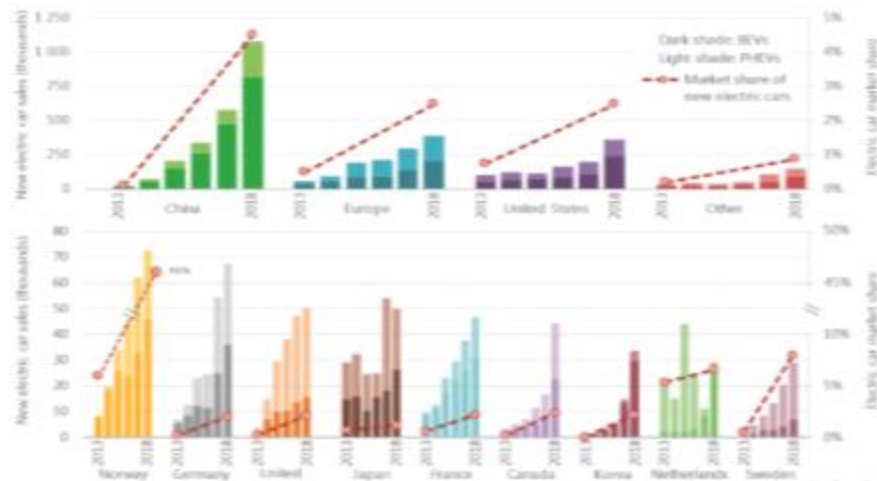
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Regional Share in Global Stock of Electric Cars - 2018



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Global electric car sales and market share, 2013-18



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Drivers of BEV Mass Adoption

- **Energy efficiency:** EVs are three-to-five times more energy efficient than conventional internal combustion engine (ICE) vehicles.
- **Energy security:** BEVs reduce reliance on oil-based fuels and can reduce dependence on oil imports for many countries.
- **Air pollution:** BEVs have zero tailpipe emissions and can address pollution issues, especially in urban areas and along road networks
- **Green House Gas emissions:** BEVs can deliver significant reductions in GHG emissions especially from road transport relative to ICE vehicles.
- **Noise reduction:** EVs are quieter than ICE vehicles and hence contribute to less noise pollution, especially in the two/three-wheeler category.

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Falling Battery Prices

- Battery price >\$1000/kWh in 2010
- By 2025 batteries will increasingly use cathode chemistries that are less dependent on cobalt, such as NMC 811 (80% nickel, 10% manganese, and 10% cobalt) or advanced NCA batteries
- Graphene Technology
- Supercapacitor (SC)



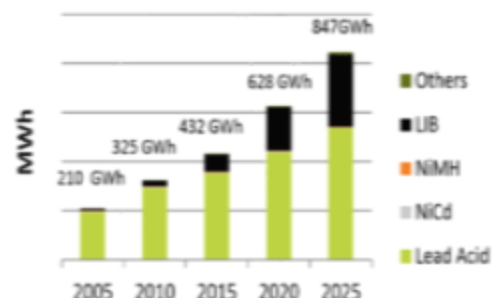
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Global Battery Market

- Global Lithium Ion Battery Market Share



- Lead acid batteries have a higher market share but LIBs have a higher growth rate
- Automotive applications accounted for over 70% of total lithium-ion battery shipments in 2018, compared to just 43% in 2015 and 6% in 2010



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Government Policies

- Critical policy measures used by leading countries:
 - **Fuel economy standards** (e.g. Corporate Average Fuel Economy, ZEV mandate etc.): used in U.S.A, China, Japan, Canada and EU
 - **Fiscal Incentives** for zero- and low-emissions vehicles (e.g. tax credits, subsidies to manufacturers and consumers)
 - **Economic Instruments** - To boost the value proposition of EVs and help bridge the total cost of ownership gap between electric and conventional vehicles (e.g. free registration or license plates, lower toll or parking fees, access to bus lanes etc.)
- Globally policy support is being used to address the strategic importance of the **battery technology value chain**.

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Government Policies

- **Procurement Programs** – To stimulate demand for electric vehicles and to enable an initial roll-out of publicly accessible charging infrastructure.
 - In the city of Shenzhen, government mandated operators to go electric, 16 000 electric buses operate, the largest-scale electric bus transition observed in a city.
 - Largest electric bus fleet procurement in Europe: 100 electric buses on routes in the Schiphol Airport area in the Netherlands
- **Infrastructure Support Policies:** Minimum requirements to ensure EV readiness in new or refurbished buildings and parking lots, and the roll-out of publicly accessible chargers in cities and on highway networks.
- **Adoption of standards** to facilitate inter-operability of various types of charging infrastructure.

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CHINA – Adoption Trends

- Target of 5 million EVs by 2020 including 4.6 million passenger light-duty vehicles (PLDVs).
- New electric vehicle (NEV) mandate: 12% NEV credit sales in passenger cars. NEVs get between two and six credits depending upon their range. OEMs must earn enough credit to match 12% of their output.
- Roadmap for NEV sales share: 7-10% by 2020, 15-20% by 2025 and 40-50% by 2030.
- Proposal for tightened fuel economy standard for cars (4 L/100 km by 2025).
- Current fuel economy standard to be used till 2020

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CHINA – Adoption Trends

- China is both the biggest manufacturer and the biggest market for cars globally.
- Buys more than half of the world's new electric cars.
- China's electric car market is 3 times larger than the US electric car market. In 2018, China had 1.26 million electric cars to 361,000 electric cars in the US.
- China has the largest volume of EV in absolute terms. But relatively, EVs still account only for a small fraction of the market.

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CHINA – Manufacturing Trends

- Uses the term New Energy Vehicles which includes BEVs, hybrids and plug-in hybrids.
- Built a complete value chain with a high percentage of locally produced components being incorporated into foreign cars produced in China
- Foreign automotive vehicle & components manufacturers must form joint ventures with local firms to enter the Chinese market
- China leads the electric two-wheeler market: produced 26 million units and had an estimated stock of 250 million units (1/4th of the global stock) in 2018
- Domestic OEMs have a 94% market sales share of the Chinese EV market
- Incentives being phased out in recent years as industry matures and cost of production falls.
- China remains the global leader in the production of both mined rare earth products and refined rare earth compounds, with Chinese production accounting for 86% of global refined production in 2017. Rare earths are a key raw material in permanent magnets which are used in electric motor for EVs.
- Research focus on Graphene Technology - China International Graphene Industry Union (CIGIU) for industrial development of Graphene.

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BEVs Value Chain in Pakistan

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Entrepreneurial ventures

- Power Electronics Pakistan (PEP), Lahore
- Jolta, Lahore
- S. Zia ul Haq & Sons (SZS), Karachi
- InerZ, Islamabad

Existing automobile manufacturers (Perspectives)

- Nishat Hyundai
- Atlas Group
- Sazgar Engineering
- Omega Industries (Road Prince)

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Component manufacturers (Current Situation)

- Battery
 - Treet Daewoo (Lead acid: deep cycle and maintenance free batteries)
 - Atlas (Lead acid)
 - Pakistan's battery industry seems to be lead acid based manufacturing
 - Some effort towards importing and assembling Li ion cells is happening
 - LUMS School of Science and Engineering (Assembly of Li ion using imported cells)
 - Challenge is optimization of energy density, charging time, price, temperature, efficiency (temperature sensitive), weight, life cycle, ...
 - Graphene based technology and ultra capacitors: globally battery constraints seem coming down sharply
- Motor manufacturing
 - Gujranwala (Golden pumps, Diamond Motors, Aikhas Motors,...)
 - Various types of motors though mostly AC motors
 - Sophistication and export orientation is lacking
 - Mostly from recycled material (electric sheets: majority recovered from international scrap; copper wire: original requires scale so second hand used; bearing: several levels of quality ABCD...)
 - Key facilities for research and development such as for testing for international standards lacking
 - Efficiency and temperature relationship
 - Can possibly reverse engineer over time (5-7 years) and designing might take longer
 - Possible role of fan manufacturing industry

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Component manufacturers (Current situation)

- Cables
 - Fast Cables
 - Two items: conductor (almost constant) and insulator (varies)
 - Current automobile market size is too small for large companies
 - BEVs can bring opportunities in 4 wheelers
 - In BEVs, unlike ICE based vehicles, temperatures not very high
 - Though lab equipment is missing it can quickly catch up
- Controller
 - Could not find a specific company
 - Companies like Jolta and InerZ are working to develop their own

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Universities and R&D Institutions

- LUMS School of Science and Engineering
 - Student projects on electric vehicles and international competitions
- NED Karachi
 - Student projects
 - Working with Mehran fans to develop motors
- UET Lahore
 - Test beds of electric motors
- UET Peshawar
- LUMS Energy Institute
 - Working with federal government to provide intellectual support in the development of BEVs encouraging policies

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International players

- Interested in:
 - Pakistan's market
 - Manufacturing for global markets
- Integrated electric kits providing combination of:
 - Battery packs
 - Battery management system
 - Motor
 - Controller
 - Battery swapping system

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Economic sense of BEVs

- Upfront cost
 - Battery is the major cost in BEVs (approximately 30-50% in Li ion based BEVs)
 - Cost goes very high with Li ion battery
 - Affordable price with lead acid but issues of lead acid
 - Li ion is the way to go – for now
- Companies in Pakistan are targeting some design innovations to bring the upfront cost down e.g., SZS (4 wheeler) and InerZ (2 wheeler)
- Operating cost attractive

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Regulatory framework

- Current Auto Development Policy 2016-21 does not have needed focus on BEVs
- Recently government has announced an electric vehicles policy
- Policy making in conflicting objectives: new players, existing players, climate change, localization
- Pakistan hoping to become a signatory of International Energy Agency's 30%@2030 initiative
- Green banking regulations of State Bank of Pakistan (mainly focus on solar energy)
- Energy supply in Pakistan is surplus in next ten years (LUMS Energy Institute)
- Energy infrastructure and business models

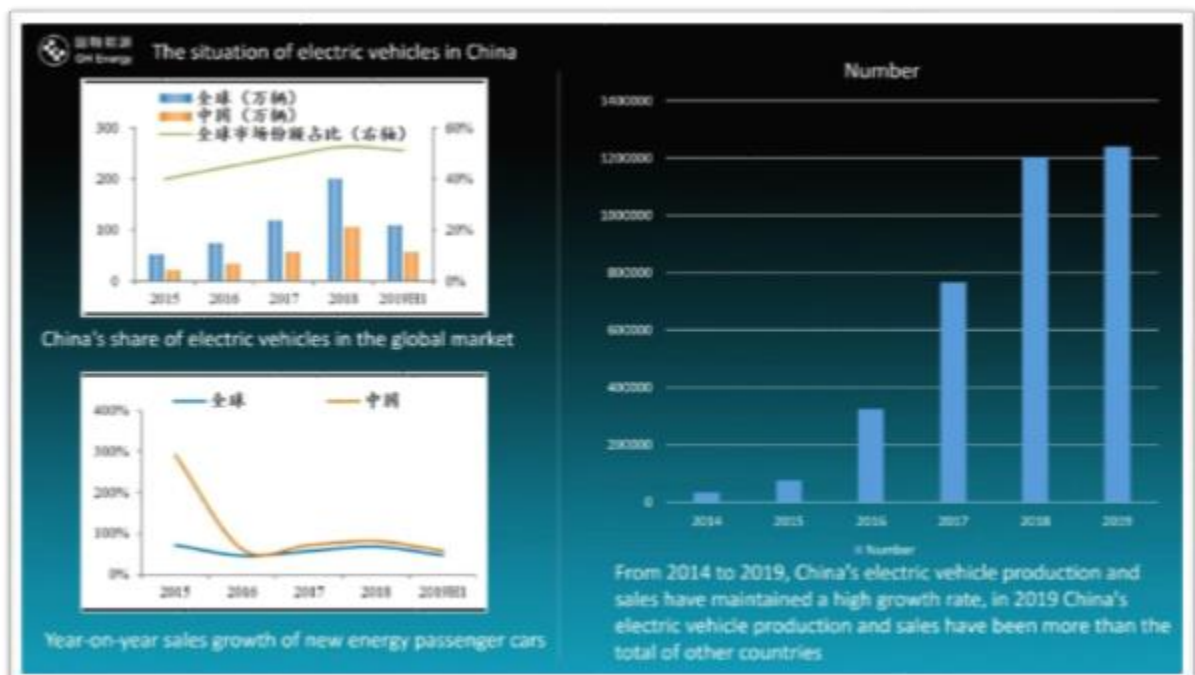
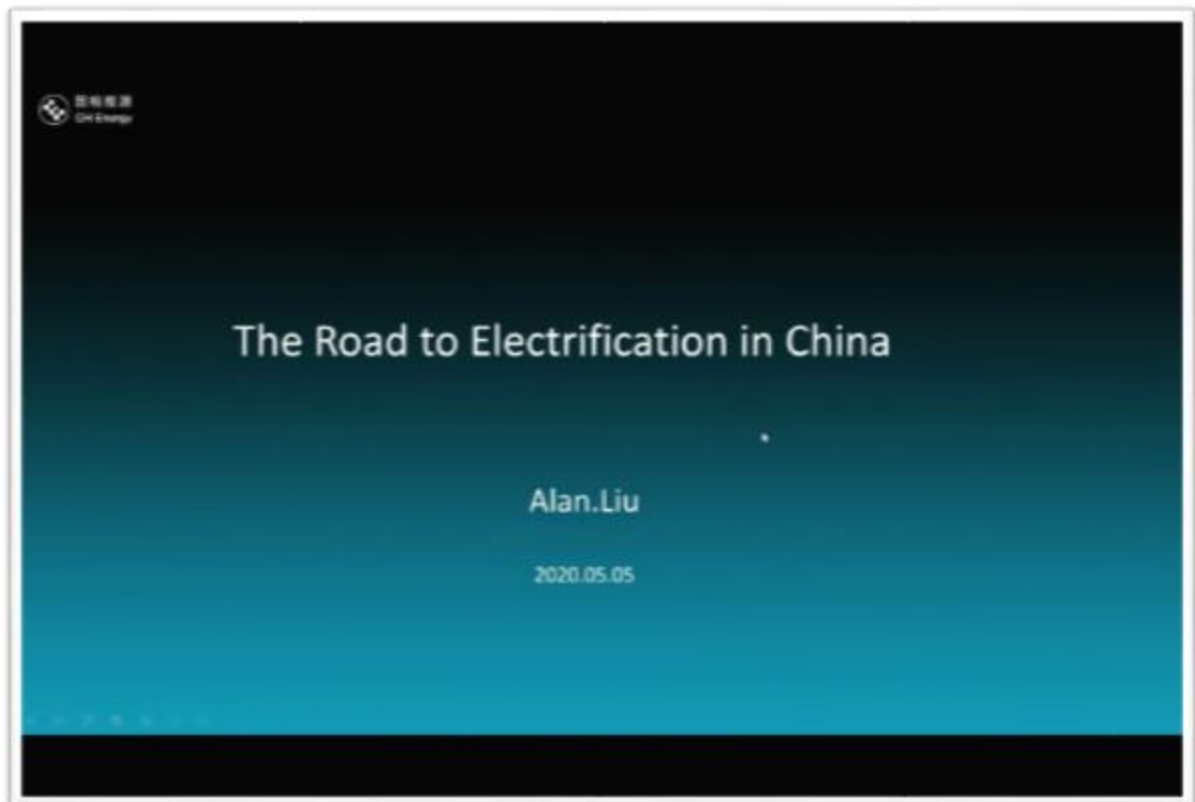
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Future Outlook - Pakistan

- Key components
 - EV kits: Seem a transition for aspirant 2/3 wheelers
 - Battery (Li ion and or lead acid) – Reducing cost: step wise localization beginning from assembly of cells
 - Battery management system: critical for Pakistani environment
 - Motor: leverage the existing knowledge to localize in 5-7 years
 - Controller: some companies are working on it
 - Body: requires innovation to bring the cost down
 - Cables: seem quite ready
- Financing (high upfront cost)
 - Loans for BEVs
 - Battery leasing models: Cars and batteries
- Starting target markets: Two/three wheelers, commercial vehicles, institutional customers
- Policy (Enhancing demand versus enhancing demand as well as localization)

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3. "The Road to Electrification in China" by Mr. Alan Liu – CEO GH Energy



2014 is the year of China's electric vehicles



In 2014, Elon Musk brought the first Tesla to China to complete the delivery
China kicks off a wave of car electricization

Since 2014, more than 200 start-ups in China have been developing and manufacturing intelligent electric vehicles

We're going through a history similar to the mobile Internet

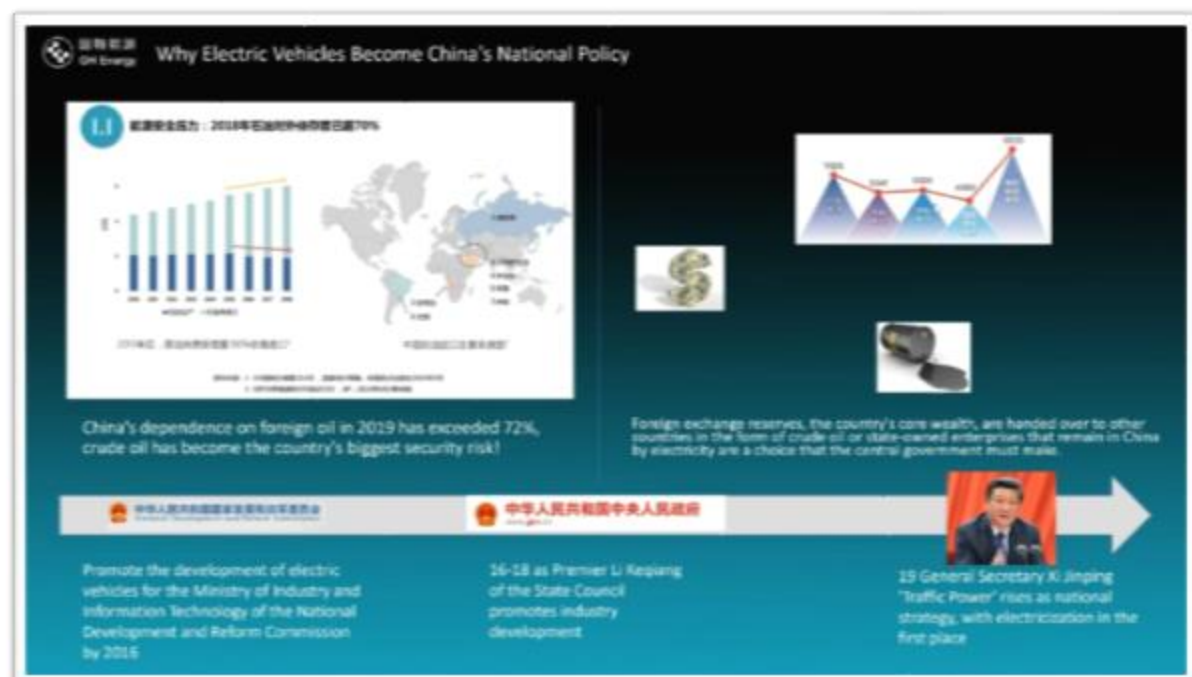


Internet companies	Industrial Chain Company	New Mobile Phone Company
- 阿里 - 腾讯 - 字节跳动 - 美团 - 滴滴	- 苹果供应链 - 富士康 - 华勤技术 - 龙旗科技 - 闻泰科技	- 华为 - 小米 - OPPO - VIVO

Change → Refactoring

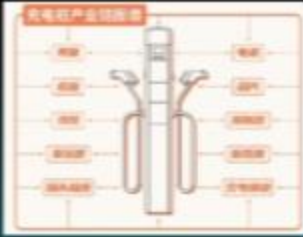
Automotive → Energy → Internet → 4G

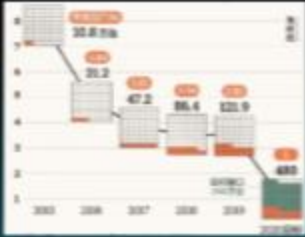
New manufacturing → New infrastructure → Energy substitution → SG&Smart industry




2020







Year	Market Size (Billion RMB)
2013	30.8
2014	35.2
2015	47.2
2016	56.4
2017	62.9
2018	68.0
2019	68.0

Tesla China plant to release maximum capacity

China's major auto companies have also unveiled ambitious plans for electric vehicles

China's government's "new infrastructure construction" plan also includes electric vehicle charging infrastructure in key areas

China's electric vehicle market will lead the global electric vehicle market for a long time


2020

Thank you!