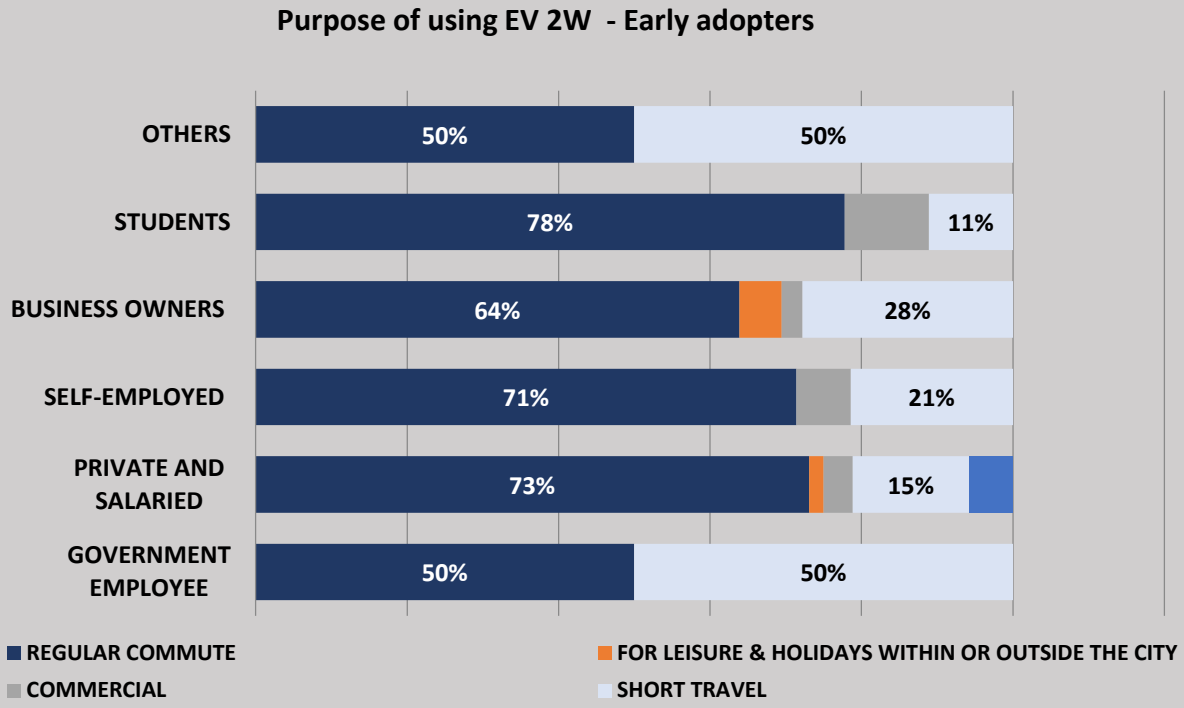
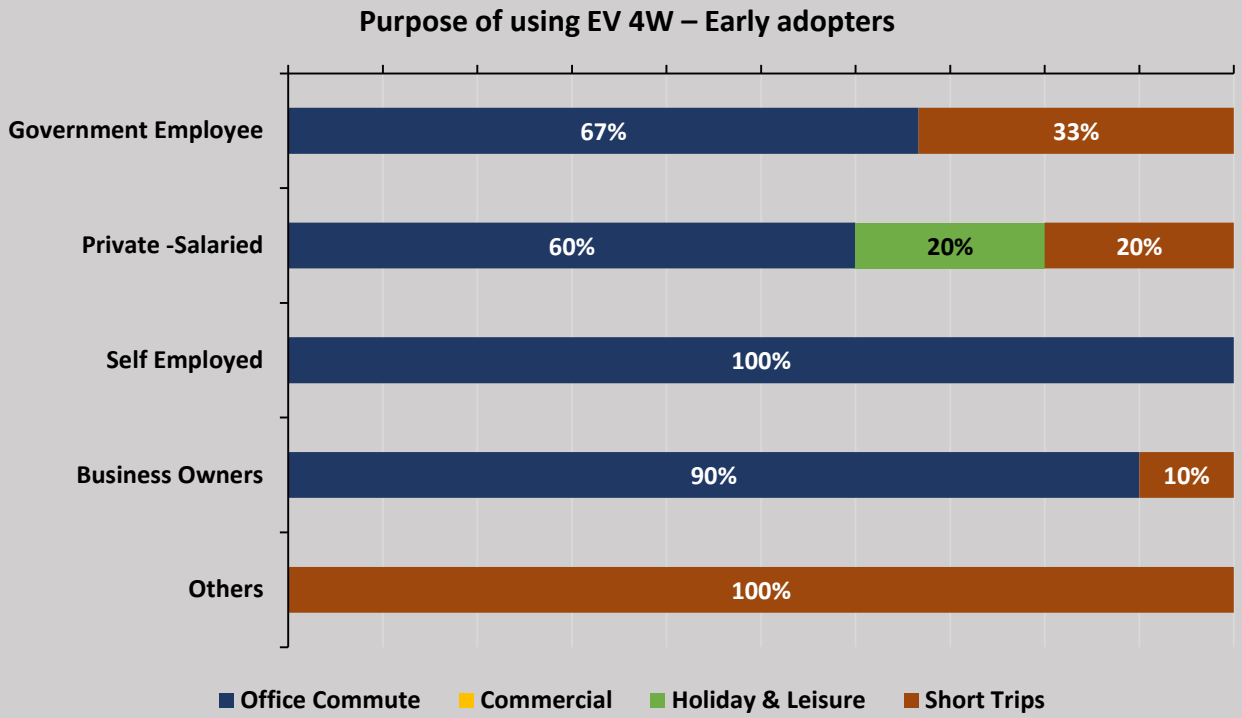
Profiling existing EV consumers and key policies to promote EVs in Delhi and the impact of EV charging on the Grid of Delhi in 2030

Methodology

- **Primary surveys of current and prospective users of EV in Delhi**
- **5 EV consumer segments surveyed covering 500 respondents across Delhi**
  - **Private EV users**
    - **Existing private users (early adopters) of EV 2W, 4W.**
    - **Prospective consumers – Who intend to buy a vehicle in next 6 months**
      - **52% of 2W buyers and 53% of 4W buyers prefer EV (EV intenders) others are conventional intenders**
  - **3W, Taxi and Institutional users**
    - **Institutional users of EV 4W**
    - **e-rickshaw drivers**
- **Survey Questionnaires designed to assess the respondents**
  - **Socio economic profile**
  - **Travel patterns**
  - **Accesses to parking and preference & availability of charging infrastructure**
  - **Charging patterns- frequency of charging and plug in time and SOC, plug out time and SOC during each instance of charging in the reference period**
  - **Suggestions and preference for various aspects of EV**
- **Survey conducted during August to September 2020 in Delhi, with the reference period being February 2020 (pre-Covid19 period)**

Consumer Profile of Private EV buyers in Delhi

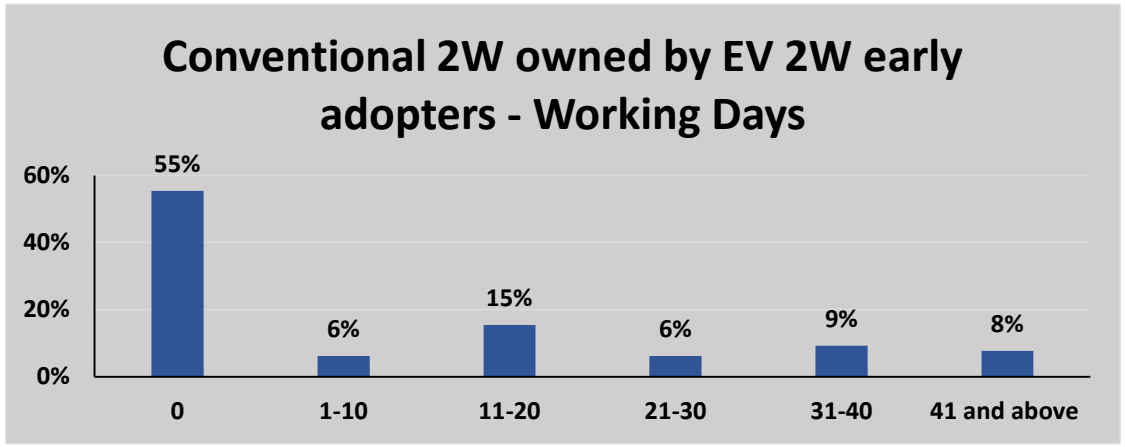


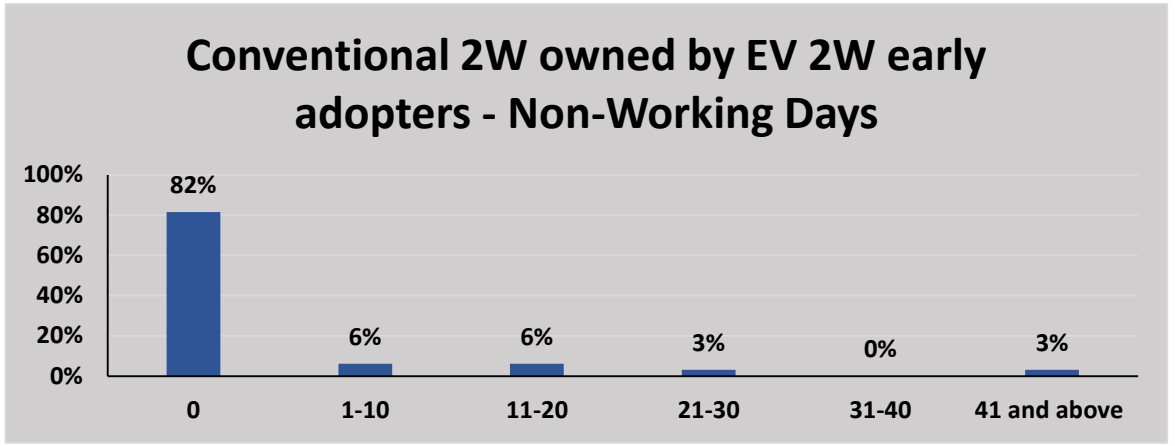


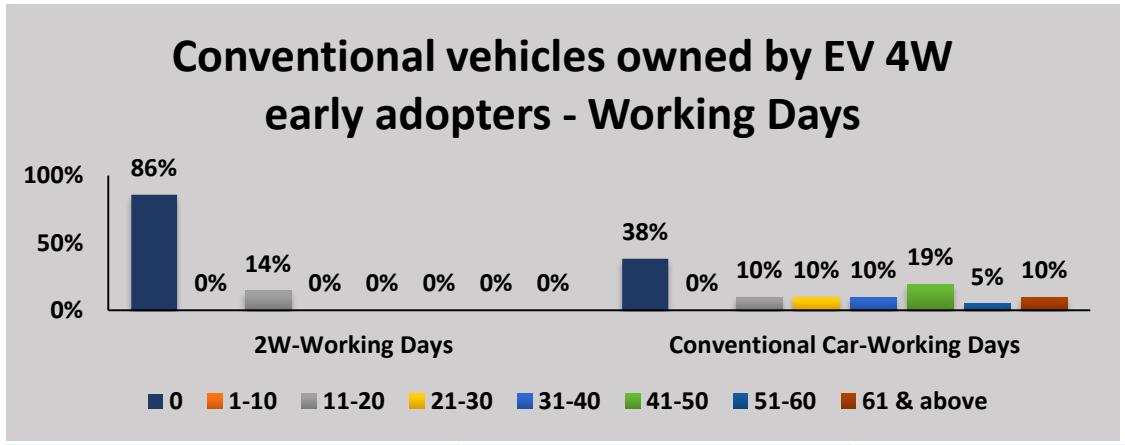
Early adopters of EV		Household Expenditure (Rs/month)	Average
2W		7,000-40,000	18,506
4W		40,000-50,000	44,286
Prospective Consumers		Conventional	EV
	2W	12,000	23,971
	4W	28,382	34,230

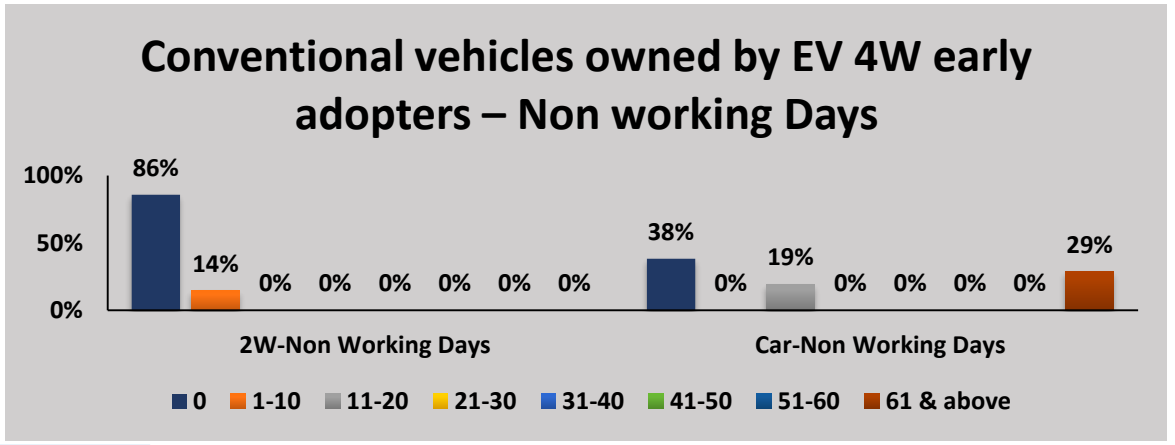
- Preference for EVs increases with income.
- EV buyers - more short distance travel apart from regular office commute
  - ✓ Early adopters of EV 2W and 4W - regular workplace trip and short distance travel.
  - ✓ Prospective consumers-EV intenders had more short distance travel apart regular office commute.
- Those already owning conventional 2W and/or a 4W are more likely to buy EV
  - ✓ 1/3rd already have conventional 2W
  - ✓ already have conventional 2W or 4W

Travel Usage of Electric vehicles by Private users in Delhi









EV		VKT (Weekdays)	VKT (Weekends)
2W		22 KM/day	11 km/day
4W		41 km/day	44km/day
Prospective Consumers	2W	29 km/day	9 km/day
	4W	34 km/day	50 km/day

- **Average daily kilometers travelled by conventional vehicle is higher than EVs on weekends.**
- **Most early adopters of EV 2W or 4W do not use their conventional 2W or 4W.**
- **Buy back policy to exchange conventional vehicle for EV with appropriate financial remuneration**

Parking and Charging access of early adopters of EV in Delhi

Early adopters of EV 2W

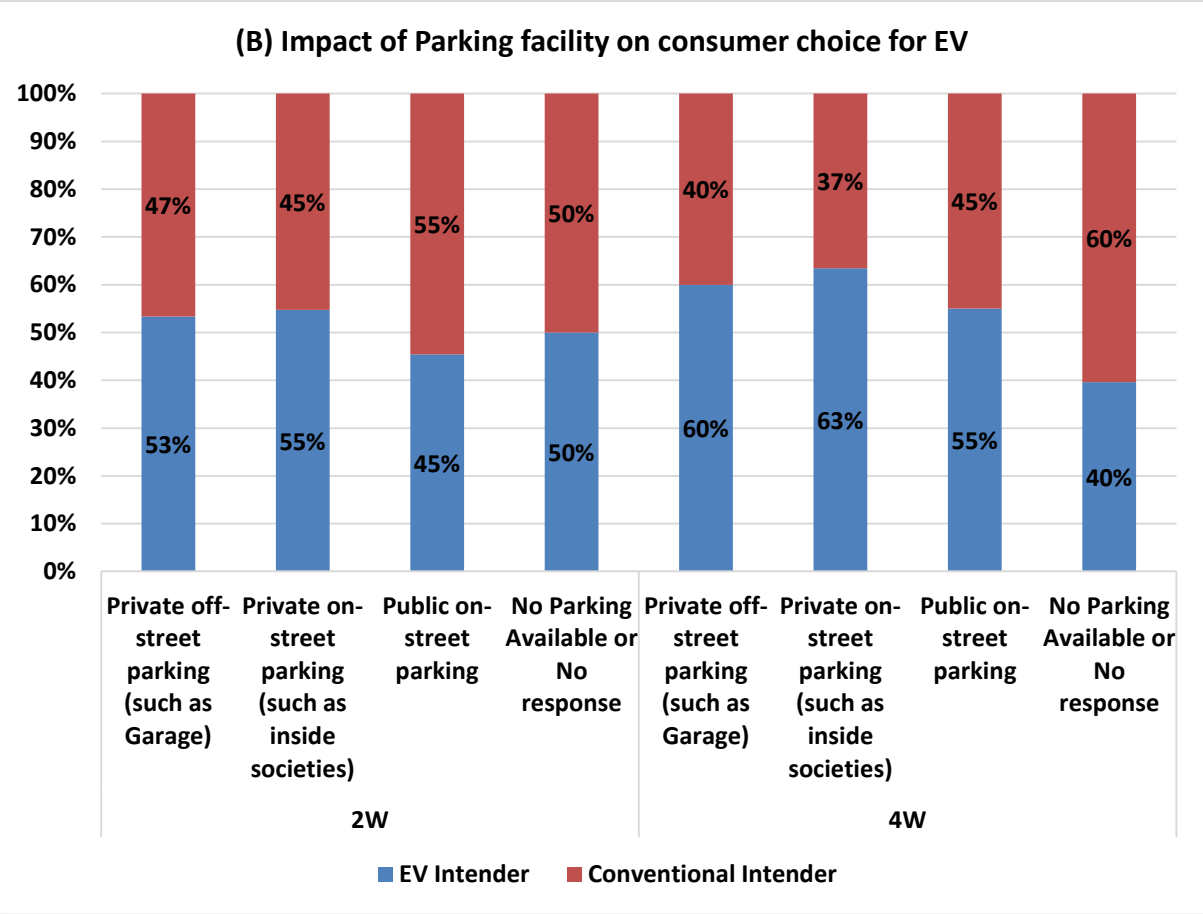
- Have access to parking facilities
- 90% charging from home and 9% have office charging options.
- 94% not aware of public charging facilities near their home or office. Among those who are aware,
  - 60% have charging station within 5 km of their home
  - 50% have charging station within 5 km of their office
- None visited a public charging station and unaware of waiting time
- Respondent suggestions
  - charging station within 2-3 km
  - all around servicing centers and free servicing in the first year

Early adopters of EV 4W

- Most have access to home or garage parking
- None opted for public charging despite 60% having charging stations within a 5 km.
- On a working day, 95% opt for home charging and 5% opt for office charging,
- On non-working days only one-third charge through home charging.
- Respondent suggestions
  - Disapproved of availability of charging infrastructure and waiting time.
  - Having public charging infrastructure within 1 km preferably or within 2 to 3 km.
  - Battery swapping facility at every station.
  - Fast charging within 90 minutes

Need awareness and increased availability of public charging infrastructure.

Parking and Charging preference of Prospective consumers in Delhi



1) **Need awareness - less than 10% of the respondents knew about public charging stations near home or office.**

2) **Public charging infrastructure not critical to EV 2W but important constraint for EV 4W growth.**

3) **Public charging infrastructure growth is important for popularizing EV among people who prefer conventional vehicles.**

4) **Around 60% preferred charging station within 1 km of their homes and offices.**

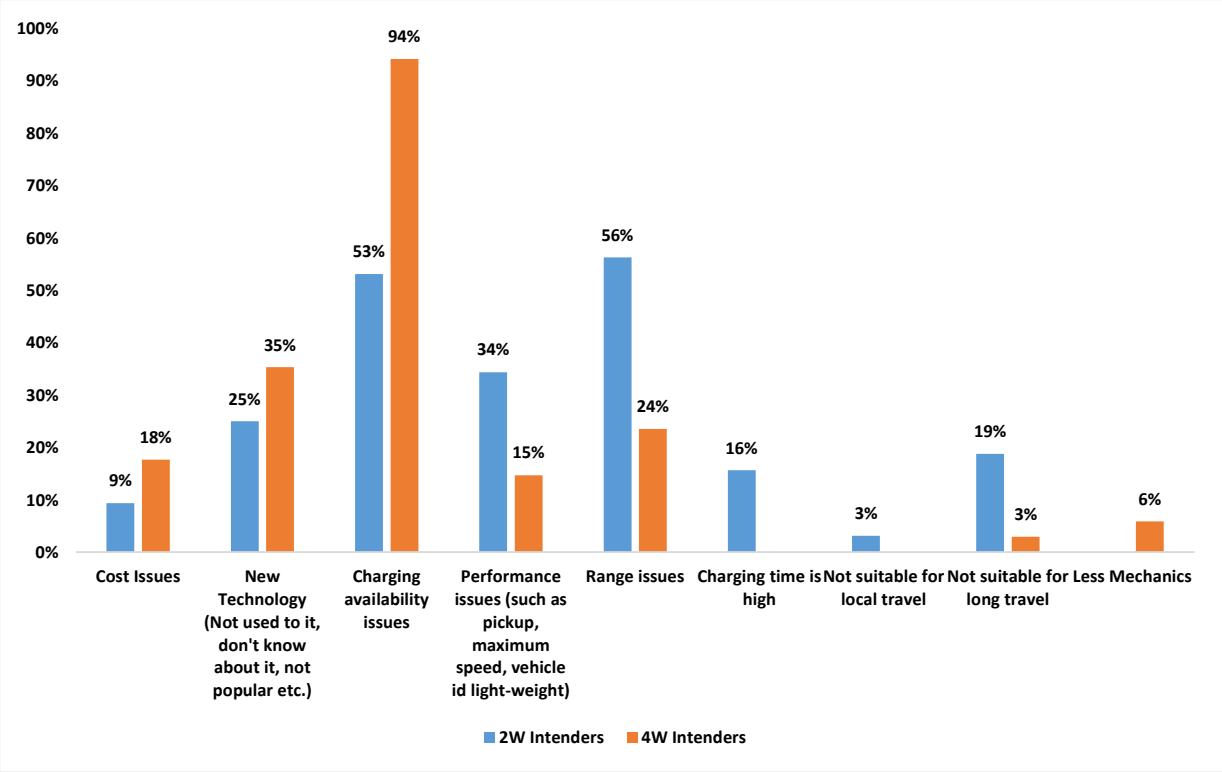
1) **Availability of parking facility is a constraint to adoption of EV in general and EV 4W in particular.**

2) **Booster charging is strongly preferred over normal charging in general.**

3) **Improving booster charging infrastructure important EV 4W buyers.**

Consumer Preferences

Reasons to not buy an EV by Conventional Vehicle Intenders



Determinants of consumer decision: Range, Charging time, Operating & Maintenance cost, Resale value and Government policy

Consumer feedbacks and suggestion

- **Policies that would make it easier to buy EV**
  - ✓ **Preferential access to express/speed lanes for EVs.**
  - ✓ **Special parking places in prime/congested areas in the city.**
  - ✓ **Tax savings or rebate in the purchase of EVs**
  - ✓ **Free public charging points**
  - ✓ **Waiving toll charges/parking charges of EVs,**
- **Policies to encourage conventional vehicles buyers to opt for EVs**
  - ✓ **Encouraging automakers to provide more models**
  - ✓ **Levying CO_2 or pollution tax on inefficient vehicles**
  - ✓ **Hybrid vehicles preferred over Battery EV for conventional vehicle buyers- introducing Hybrid vehicles or improving the range and performance of Battery EV**

- **Cost reduction of 36% to 54% for EV 2W, 40% for SUVs and 20%-40% for Sedans.**
- **Range improvement - EV 2W – from current average 54 to 100 or 150 km/charge, Sedan - from current average 120 to 300 km/charge, SUVs - from current average 300 to 400 km/charge.**

EV Policy for Private EV users in Delhi

A. Technology Policy				
	2W	4W	Prospective Consumer	
			2W	4W
Price (Expected reduction through subsidies or other measures)	36-54%	SUV-40% Sedan-20-40%	Similar	Similar
Expected Average Range	Scooters- 54km/charge Motorcycles- 104 km/charge	Hatchback- 76-92 km/charge Sedan- 120-130 km/charge SUV-280-312 KM/charge	Scooters-54-150 km/charge	Sedan- 120-300 km/charge 300-400 km/charge
Battery	Prefer hybrid vehicle over battery electric vehicle			
B. Parking Policy	Home (90%)	Home (81%) Street or society (19%)	Lack of parking spaces hindrance for adoption of EV	
C. Public Charging Policy				
Charging at home	90%	95%	--	--

- Public charging infrastructure essential for EV adoption and critical for EV 4W growth
- Need awareness and promotion of public charging stations and free public charging points.
- Public charging station within 1 km preferably or within 2-3 km of homes or offices.
- Increasing Booster charging facilities as public charging stations.

Economic and Incentive Policy

A. Buy Back Policy

- Early adopters of EV 2W and EV 4W own a previously purchased conventional 2W and/or 4W.
- Most early adopters of EV in delhi have replaced their conventional vehicles with EV.
- Buy back policy that provides EV in exchange for conventional vehicles compensating for its remaining economic life.

B. Parking Policy

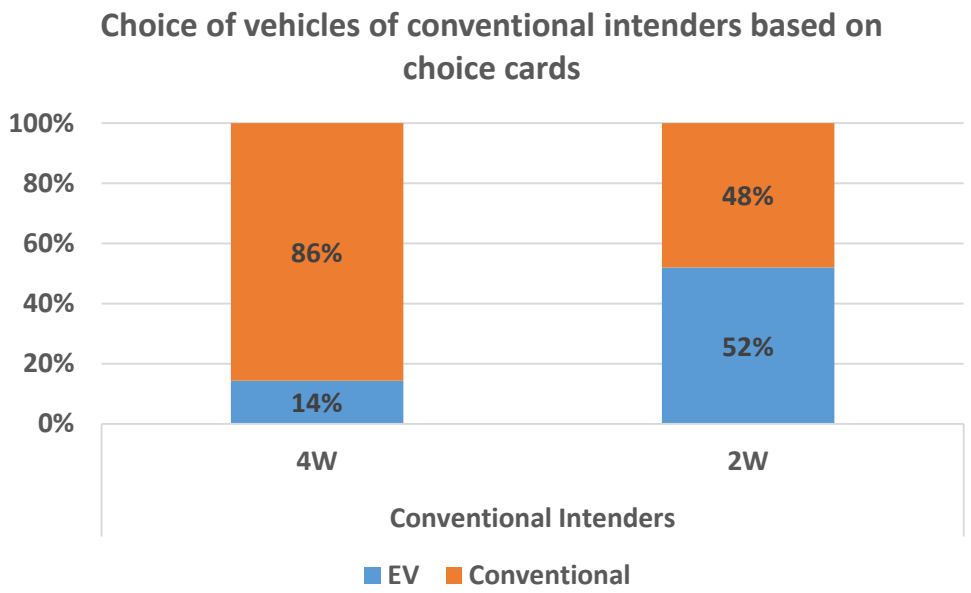
- Availability of parking space constraint for EV growth.
- To ease parking constraint for EVs, roads and parking places in Delhi needs to be de-congested.
- Parking markets and parking tax on pollution and inefficient vehicles

C. Subsidy and other Incentives

- EV adoption increases with income. Subsidies may be considered to increase EV adoption.
- Preferential access to express/speed lanes for EVs.
- Special parking places in prime/congested areas in the city.
- Tax savings or rebate in the purchase of EVs
- Free public charging points
- Waiving toll charges/parking charges of EVs,

Promotion & Awareness Campaign

Preferred Vehicle Choice based on Choice Cards



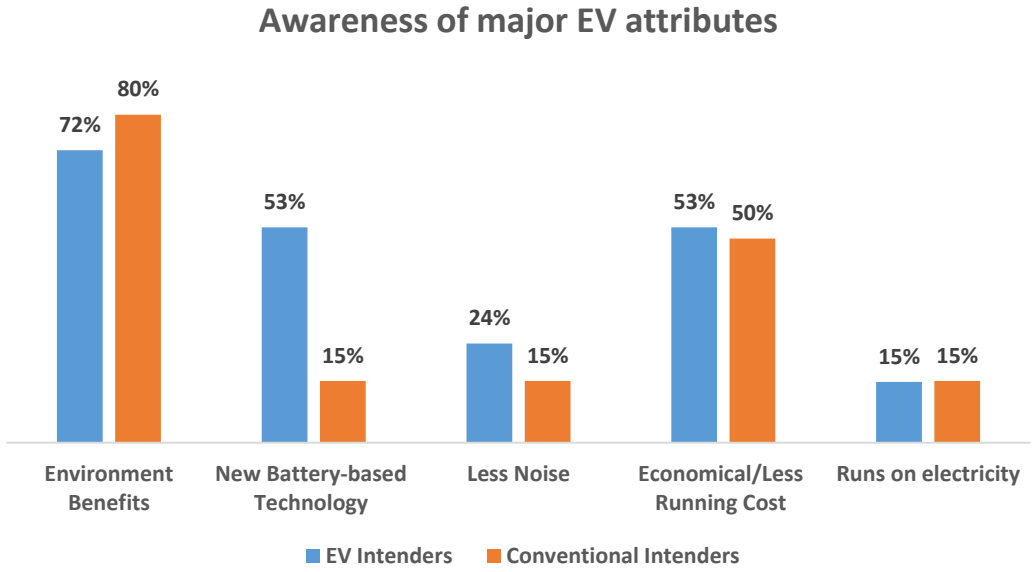
Social Groups for Promotion

- Professional Groups who are early adopters of EV
  - Business Owners, Private salaried individual – **Advertising in Offices and Market areas**
- Professional Groups who showed strong liking for EV (EV intenders)
  - Women, Student, Salesman – **Promote EVs through Mobiles and Social Media, Advertisements, Educational Institutes**
- Frequent users of public transport like metro, auto-rickshaw, shared cab and e-rickshaws are more likely buy EVs.
  - **Advertise in Metro trains and metro stations** which are boarding points of e-rickshaws

Comparative choice of EV and conventional 2W and 4W based on capital cost, operating cost, EMI, Range or Mileage (Assuming diesel price of INR 66/Litre, electricity price INR 6/kWh, the annual run of 12,000 km

Promotion Strategy

- New battery-based technology and less noise are benefits of EV that EV intenders were more aware than conventional intenders
  - Highlight range, utility in short distance, new battery-based technology, less noise, less mechanical parts and availability of public charging points during promotions



Charging behaviour of Private EV owners in Delhi

Early adopters of EV 2W

- 55% charge less than once a day and 39% charge them once a day
- Average time to full charge -7 to 8 hours.
- The regular charging time - 7 pm to 8 am
- Top up charging by EV 2W owners
- Weekdays - 9% opt for top-up charge
  - 4% at 8 am to 12 pm, 2% at 10 am to 2 pm and 3% at 1 pm to 5 pm.
- Weekends -16% opt for top-up charge.
  - 7% at 8 am to 11 am, 2% at 9 am to 11 am, 5% at 10 am to 1 pm and 2% at 11 am to 2 pm.
- The average Plug-in SOC: working day is 24% and non-working days is 34%

Early Adopters of EV 4W

- Only one-third charge 7 times a week and another one-third charge it 3 times a week.
- Average time to full charge an EV 4W – 9 to 10 hours and up to 2 hours in fast charging mode.
- Regular charging time - 5 pm to 7 am
- Top up or fast charging options not used
- The average Plug-in SOC: working day is 34% and non-working days is 36%

3W, Taxi and Institutional users in Delhi

A. Institutional EV 4W: Taxi aggregators and Institutional users

A.1 Driver and Vehicle Profile

- Belongs to the age group of 24-39 years
- 72% of the EVs surveyed belong to private firms
- Mahindra E-Verito (56%) is the most preferred EV 4W model used by fleet operators, followed by Tata Tigor (36%)

A.2 Travel Pattern

	Operational days	Daily Average Distance Travelled
Government	7 days a week	90 km/day
Private Organizations	6 days a week	114 km/day

A.3 Driver Preferences

- 90% mentioned range and 54% mentioned availability of public charging infrastructure as an issue to improve.
- Availability of Public charging infrastructure & higher waiting time for charging are the aspects for which respondent drivers are least satisfied so,25% recommended hybrid vehicles and 75% preferred battery Evs.
- Improvement in Range (90% drivers reported range as an issue)
- Free servicing, maintenance, repair and battery replacement services are high on wish list of the drivers

A.4 EV Policy	
1. Technology Policy	➢ 19% suggested improvements in the range of EV 4Ws, ➢ of which 47% suggested a range of 200-250 km and 40% suggested more than 250 km.
2. Parking Policy	➢ 80% parked in office premises, 16% in streets or public space and 4% used garage
3. Public Charging policy	➢ 75% charge at the office and only 22% at public charging stations. ➢ 13% suggested improving the charging time of their EV 4Ws, of which ➢ 36% preferred a less than 1 hour, 43% suggested 1 hour, 21% suggested more than 1 hour. **Likable Factors** ➢ Drivers prefer fast charging to save time during working hours. ➢ No parking charges **Non-Likable Factors** ➢ Drivers do not prefer to charge in public stations due to the long waiting time ➢ Unavailability of public charging infrastructure - mentioned by 54% ➢ poor infrastructural amenities

A.5 Economic and Incentive Policy

➢ Tax breaks may be considered for those who use electric cars to meet their transport requirements.
➢ Electric car use by government can be increase through mandates and policy stipulation.

Promotion and awareness Campaign

Lack of awareness among institutional EV 4W drivers about sales services offered - advertising and awareness campaign for marketing of services is required for electric taxis.

B. E-Rickshaw

B.1 Driver and Vehicle Profile

- Belong to the age group of 24-39 years
- The average income of E-Rickshaw drivers is 16,786 Rs. / month . No fixed structure of Fare
- 83% were owners and 17% had it on rent. (Rent is between 150-300/day)
- 97% of the e-rickshaws were being used for passenger transport and 2% were into passenger and freight transportation.

B.2 Travel Pattern

Charging Time	Working Time (Weekdays & Weekends)
10 hrs	14 hrs

- An average trip rate is 2.5 trips/ hour with an average distance of 3.64 Km/trip implying an average daily VKT of 127 Km/day while on weekends the average trip rate was 1.95 trips/hour with an average distance of 3.64 Km/trip implying an average daily VKT of 99 Km/day.

B.3 Driver Preferences

Range	Low Price	More public/private charging points	Batteries	Low charging cast	Fast Charging
58%	46%	19%	10%	6%	4%

- 93% of the drivers said e-rickshaw are good return on investment.
- Other benefits are higher profitability, low running cost & government subsidy.
- Preference for fast charging

B.4 EV Policy	
1. Technology policy	➢ 60% of e-rickshaw driver suggested that increase in range can increase their incomes ➢ Suggested range- 75-100 km/charge
2. Parking Policy	➢ 53% charge at private parking facilities ➢ 45% were charging at their homes ➢ So, lack of parking facilities in private charging stations can be a constraint to the growth of e-rickshaws
3. Public Charging Policy	➢ Charging at home or at commercial charging points ➢ No fast charging due to lead-acid battery - introduction of LI Batteries needed ➢ Dependence on public charging points - Promote private business for parking and charging facility to electric cabs and e-rickshaws.
B.5 Economic and Incentive Policy	
➢ All E-Rickshaw drivers belongs to low-income groups ➢ Self financing is the major source to finance e-rickshaw - easy finance schemes required	
B.6 Promotions and Awareness Campaign	
➢ After sale services are ranked highest in decision making for e-rickshaws ➢ Awareness and promotion campaign for e-rickshaw purchase should highlight after sales services being offered	

Charging behaviour of EV- 3W, Taxis and Institutional 4W

Taxis and Institutional 4W

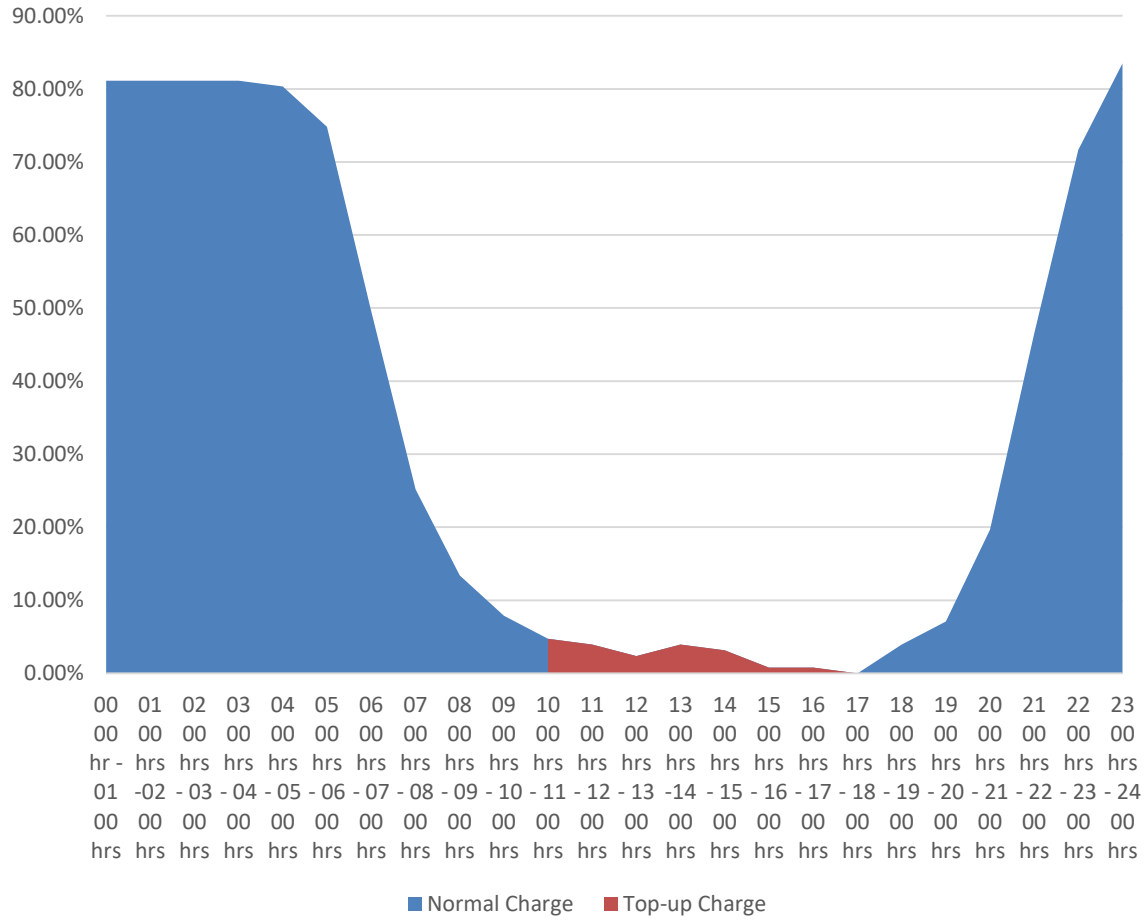
- 46% charge once a day and 50% charge twice a day.
- Vehicle is charged on the working days only.
- Fast charging is used by almost all drivers
- Almost 40% of vehicles are charged at 6 am to 7 am
- Around 30% at 8 pm.
- lowest charging load- 5-10% of the vehicles top up charged at 9 am to 5 pm.
- The average Plug-in SOC on working day is 39% with an average charging time of 3.6 hours

E-rickshaws

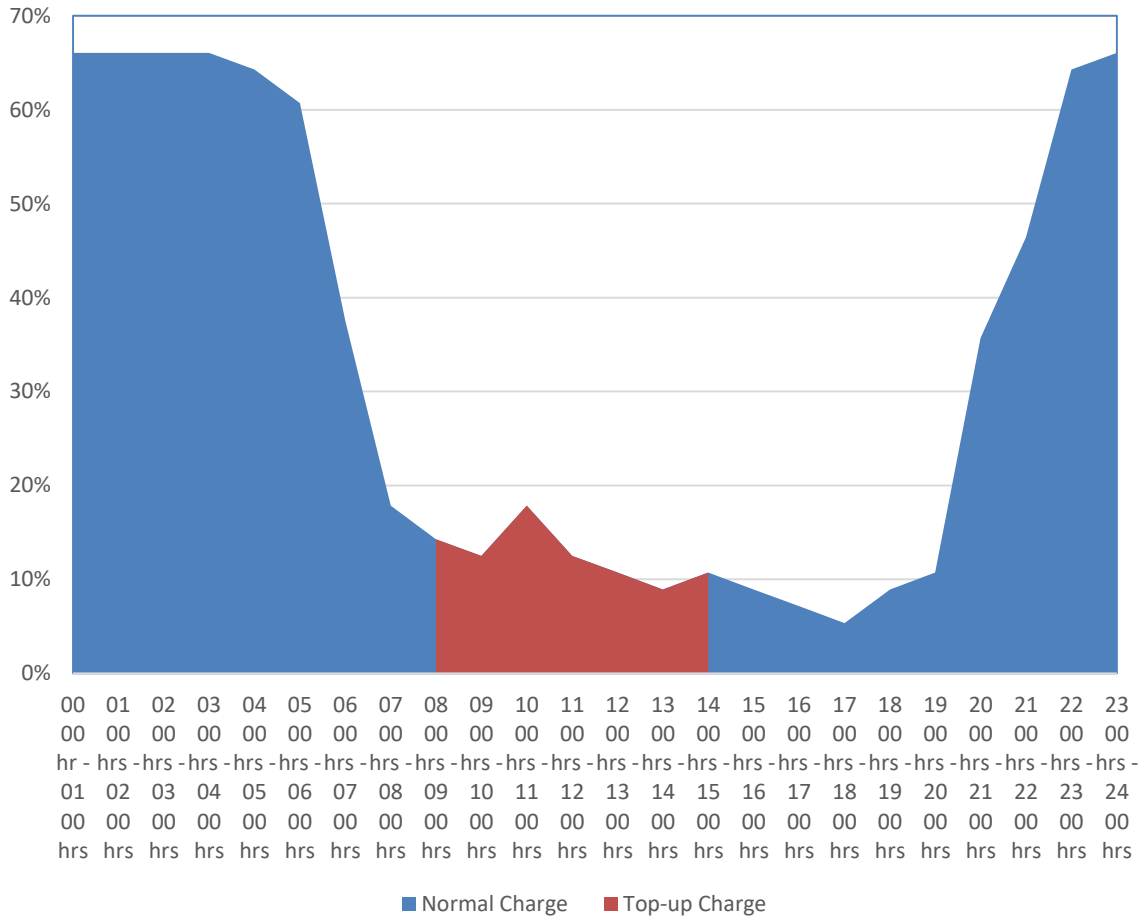
- Majority charge once a day.
- Average charging time is 10 hours and average SOC at plug in is 23% in weekdays and 24% in weekend.
- Plug-in time: weekdays is 9:00 pm to 8:00 am, weekends is 10:00 pm to 9:00 am
- The top-up charging during 12 pm-2 pm, 2 pm-4 pm and 1 pm-4 pm.

2W Charging pattern estimated from the survey

Weekday

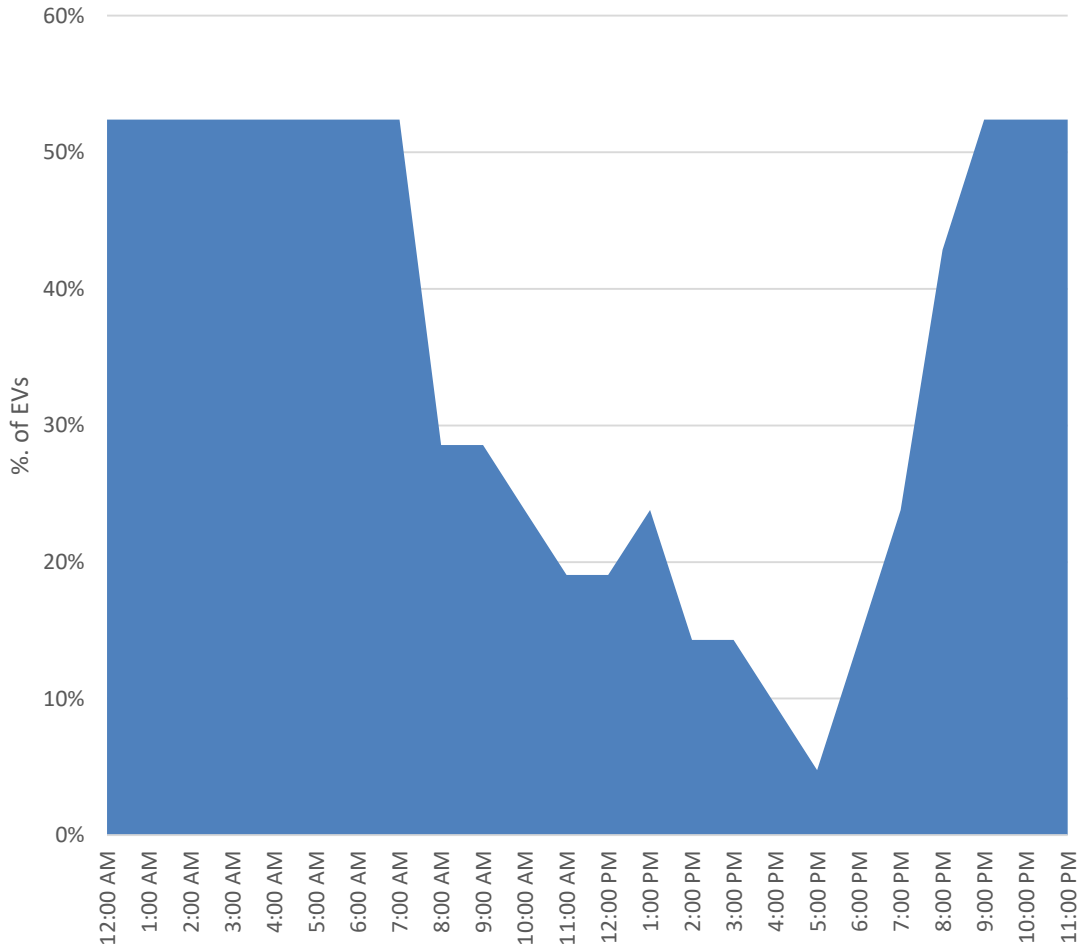


Weekend

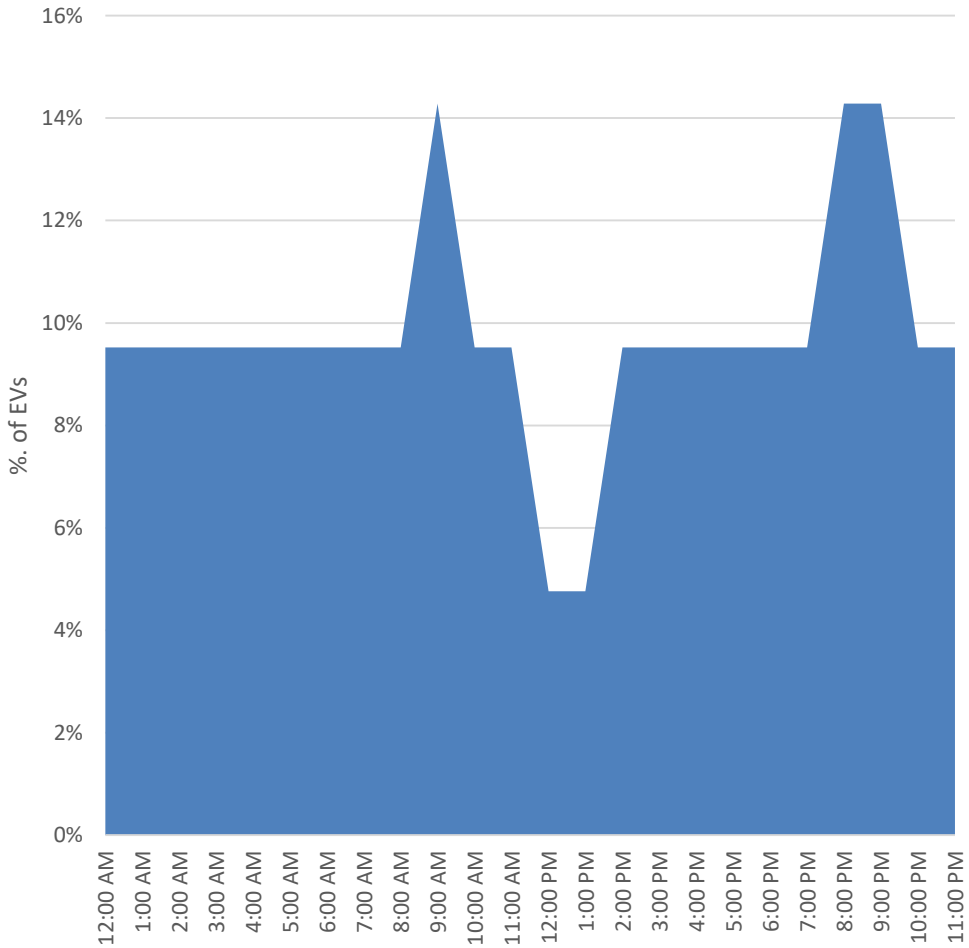


EV 4W Charging pattern estimated from the survey

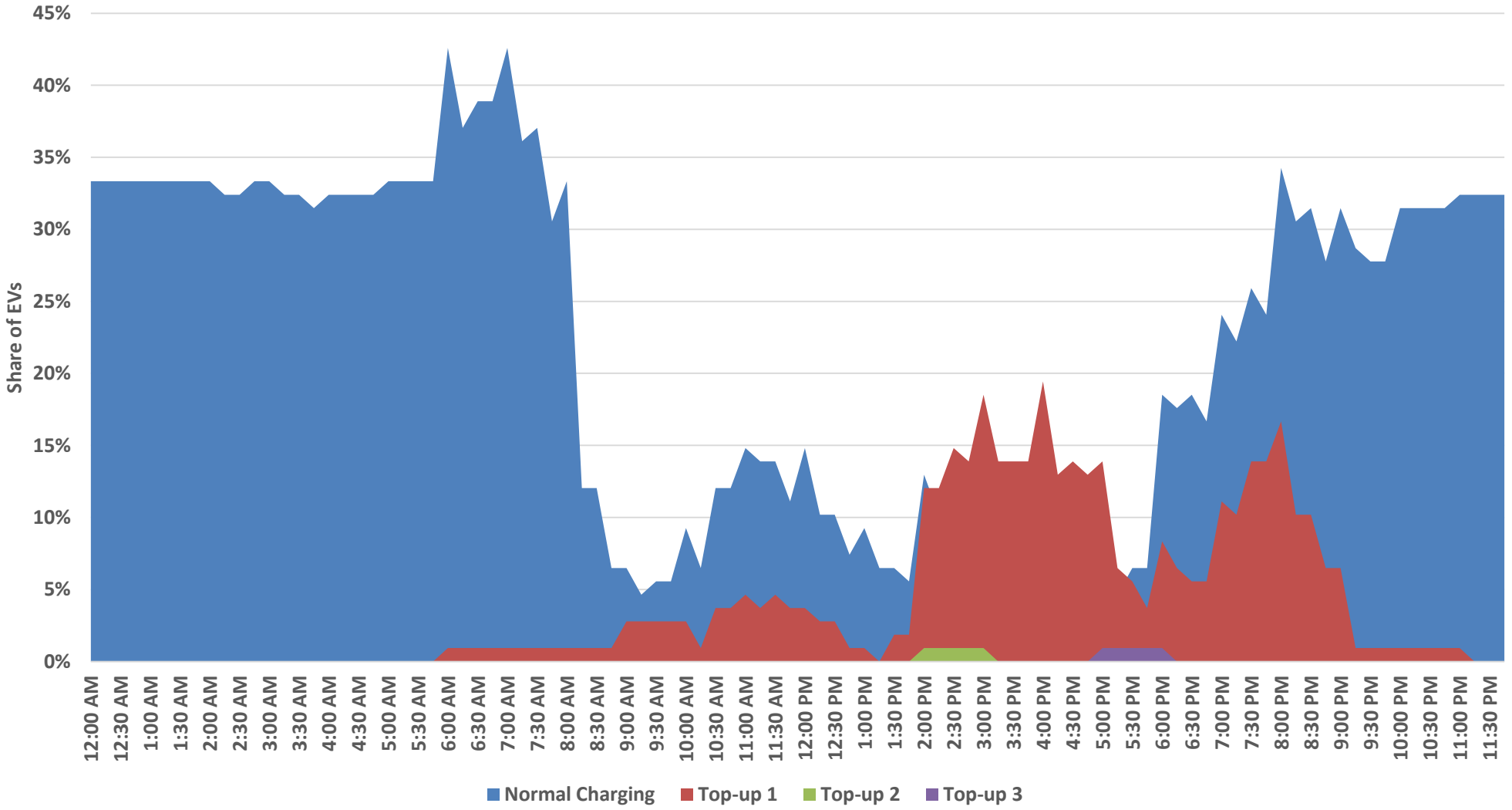
Working Day/Weekday



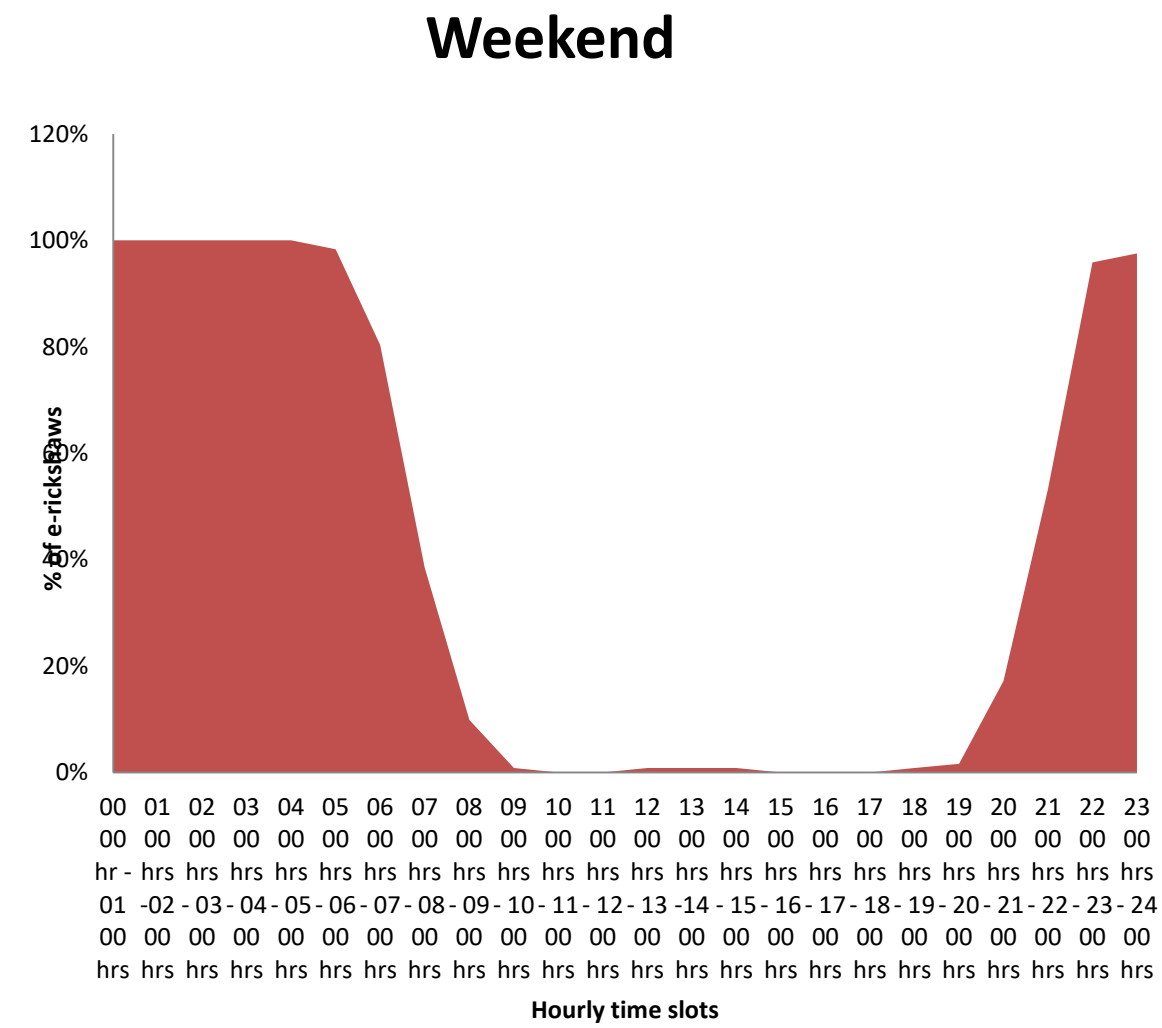
Non-working Day/Weekend

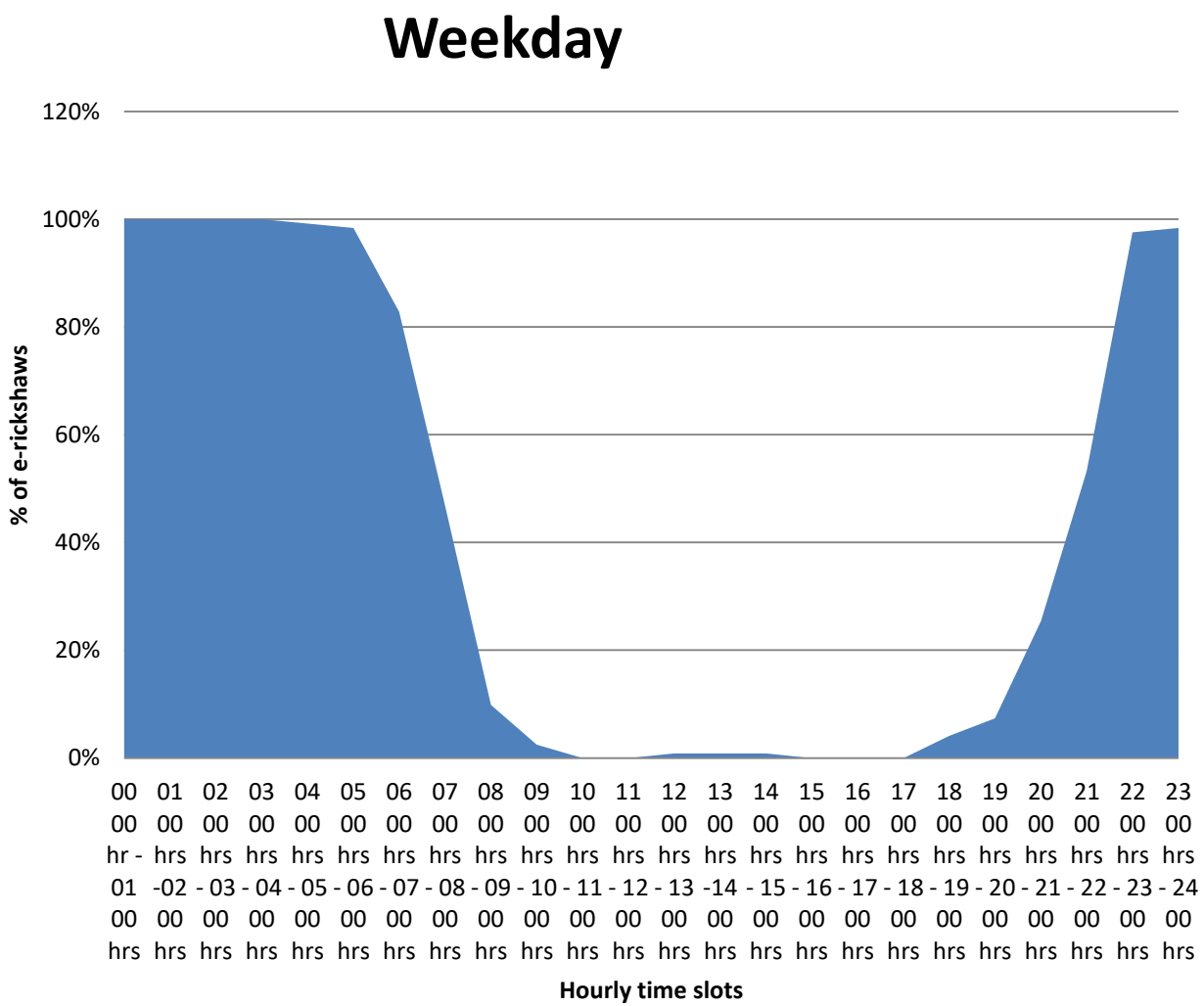


EV 4W Charging pattern on working days estimated from the survey



E-rickshaws Charging pattern estimated from the survey





Methodology for assessing impact on grid in 2030 from EV's charging

Assumptions & Methodology

1. Following data from the survey was sourced (For Weekday & Weekend):
   - **Battery capacity** in KWhr (If KWhr not available , then Capacity in Ahr and charge voltage was used to find out battery capacity in KWhr)
   - **Time taken to charge from 0 -100 % (in hours)**; partially manufacturer's manual also used for sourcing this data
   - Time of **Plugin and Plug out**
   - **State of Charge** at the time of plugin
   - Total **Count of Vehicles surveyed -** segregated based on the manufacture
2. Calculated Charging Rate and % of individual vehicle type in total Vehicle Count
3. Grouping of each category of vehicle based on its charging plug-in time
4. Each group is then assigned the share of that specific category of vehicles charged at its plug-in time
5. Step 3 and 4 is repeated for separate state of charge (SoC) values

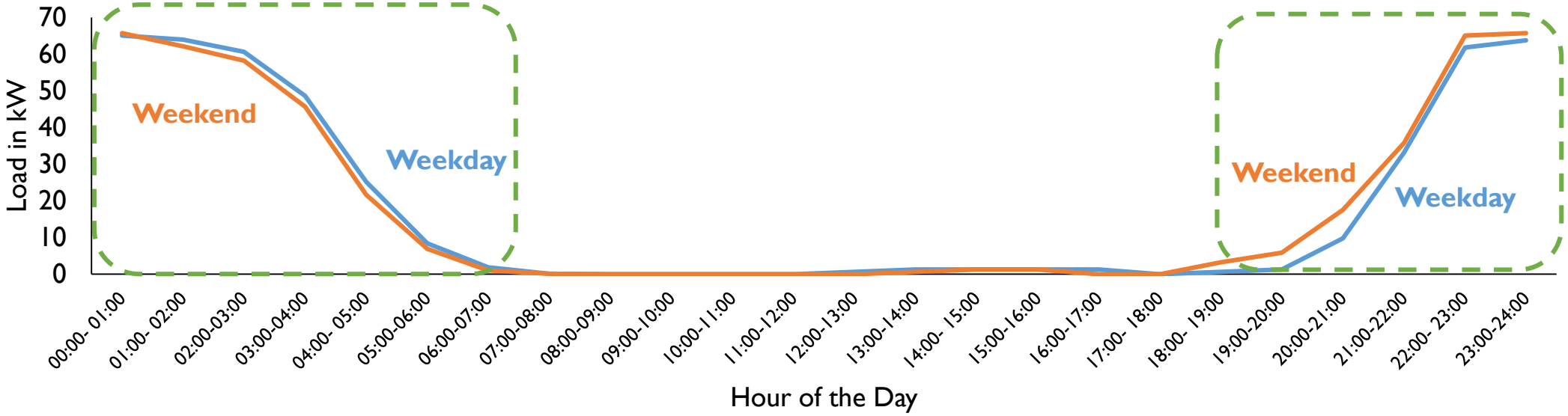
Impact of EV's Surveyed

(Survey undertaken in Sep-Oct 2020)

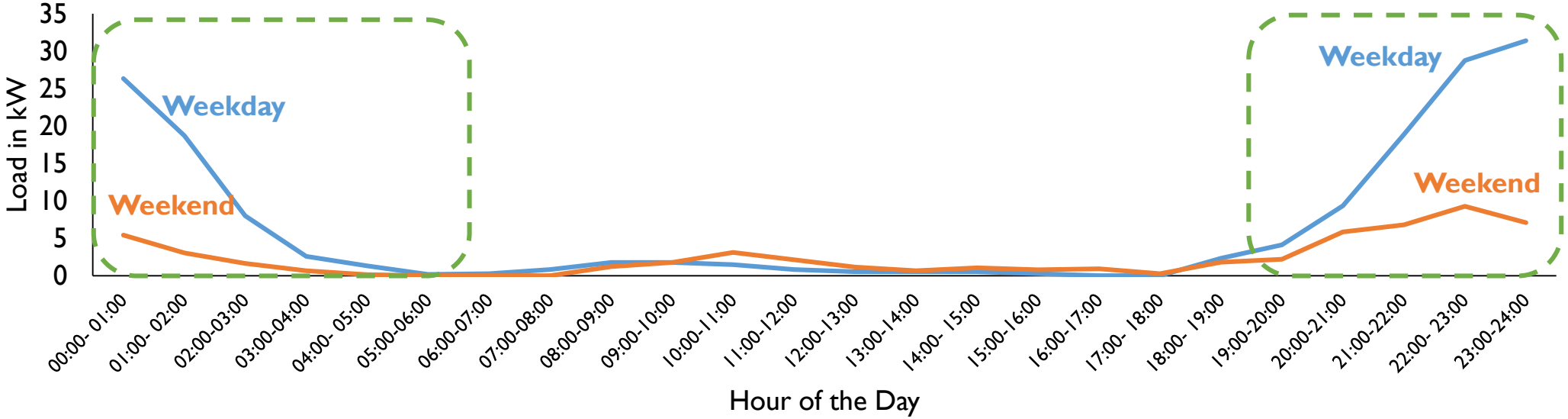
Hourly Impact of EV's based on surveyed vehicles

No. of surveyed vehicles charging on		
	Weekday	Weekend
2W	123	56
3W	122	122
4W (Pvt.)	20	7
4W (Inst.)	167	0

Impact due to **E-rickshaw**



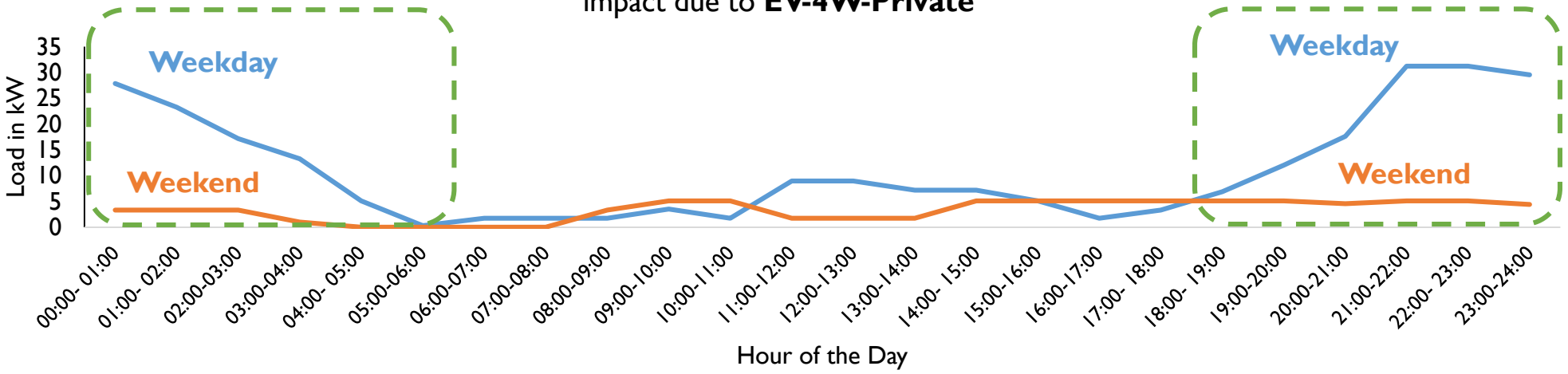
Impact due to **EV-2W**



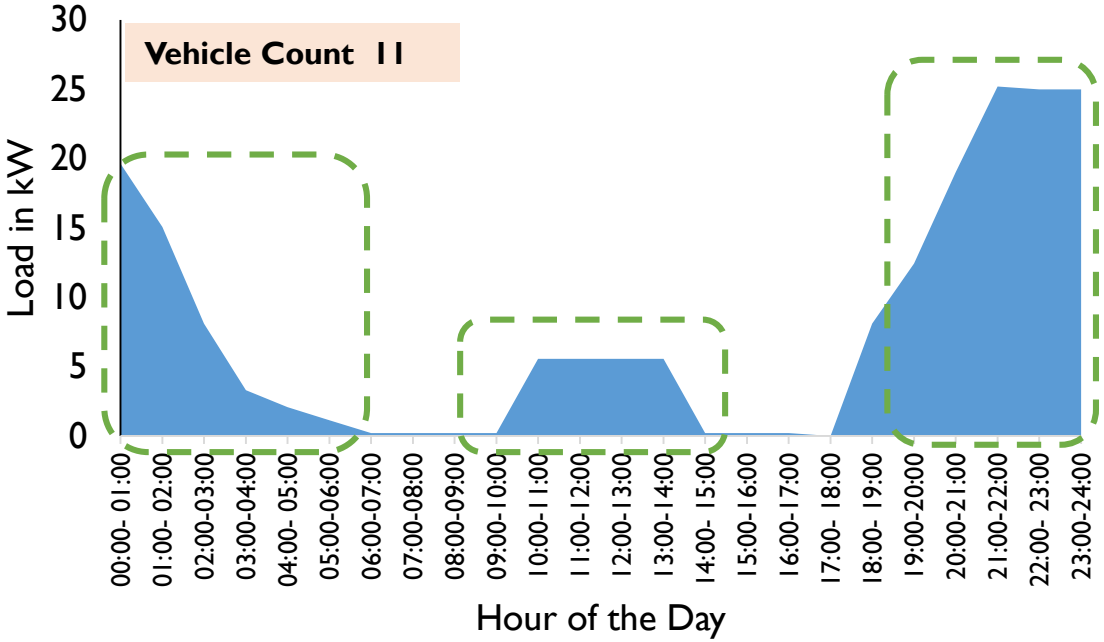
Hourly Impact of EV's based on surveyed vehicles

No. of surveyed vehicles charging on		
	Weekday	Weekend
2W	123	56
3W	122	122
4W (Pvt.)	20	7
4W (Inst.)	167	0

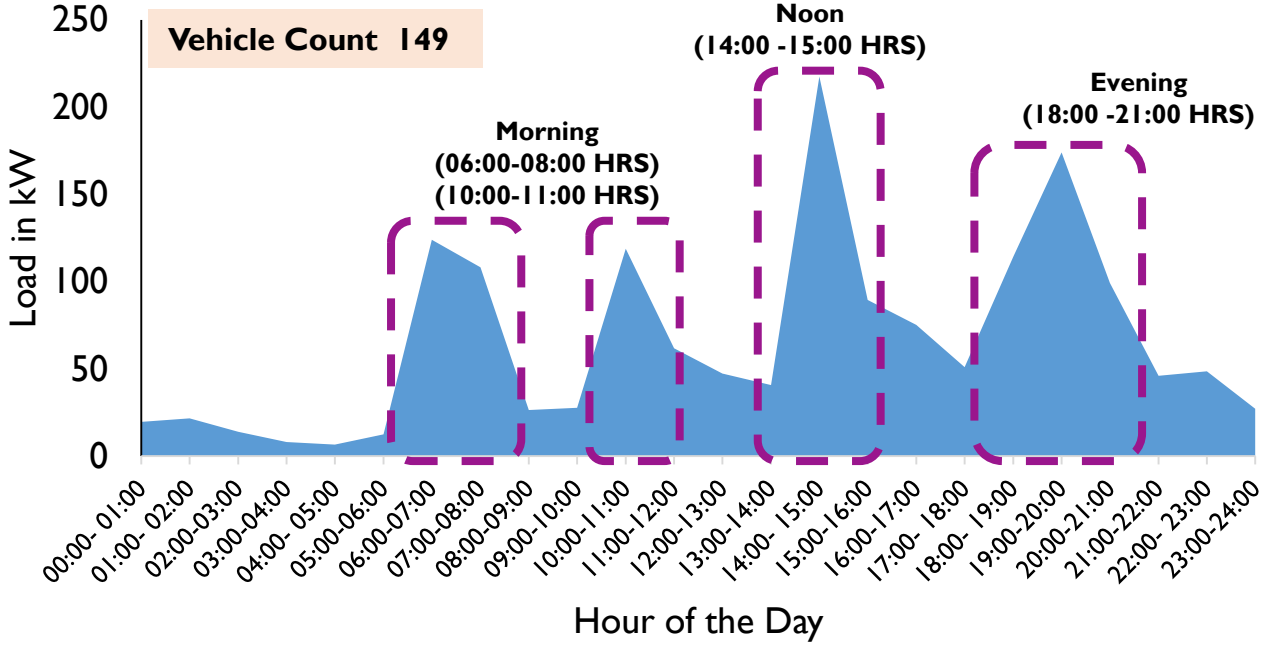
impact due to **EV-4W-Private**



Impact due to **EV-4W(Institutional) slow charging** on a **Weekday**

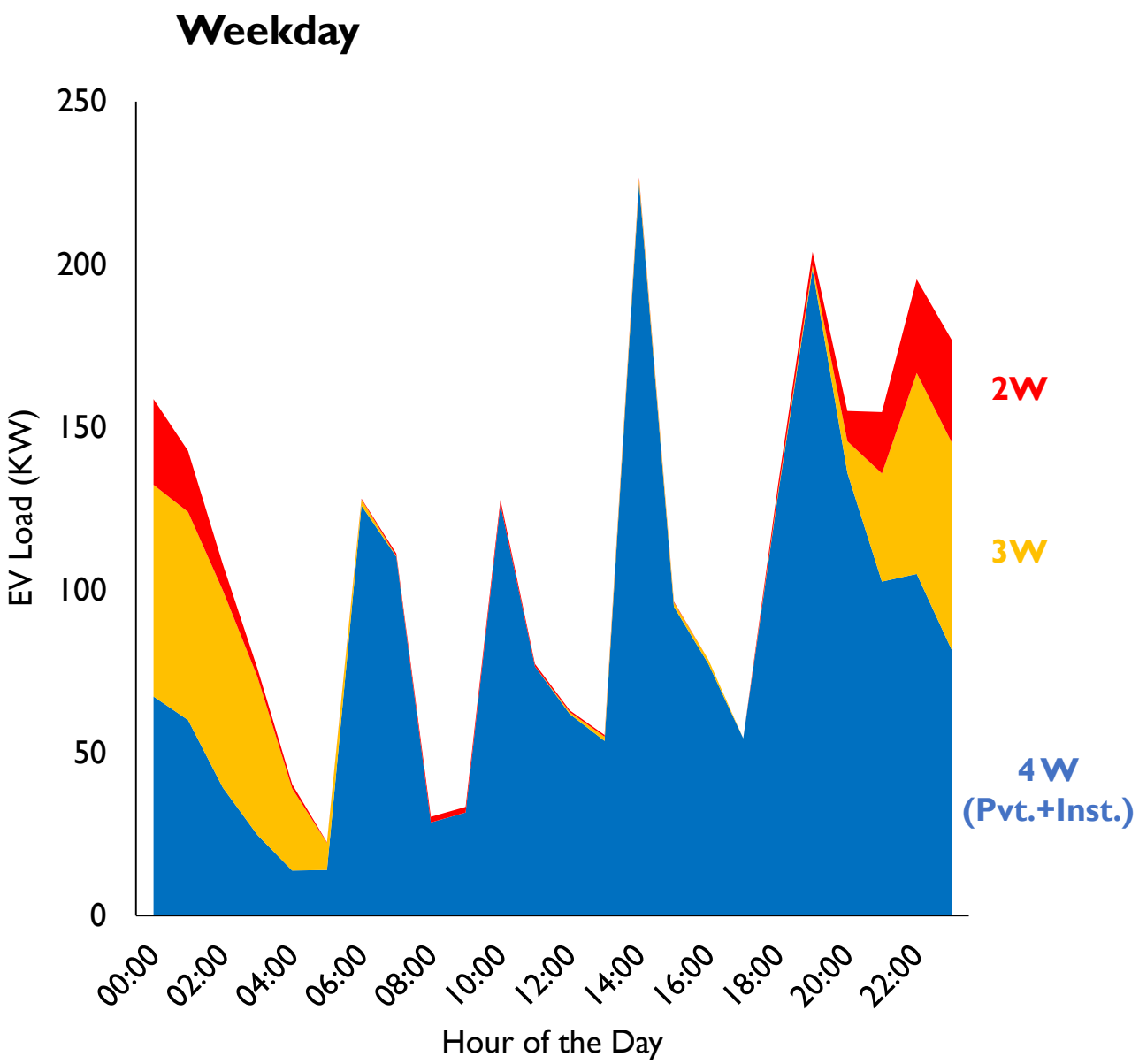


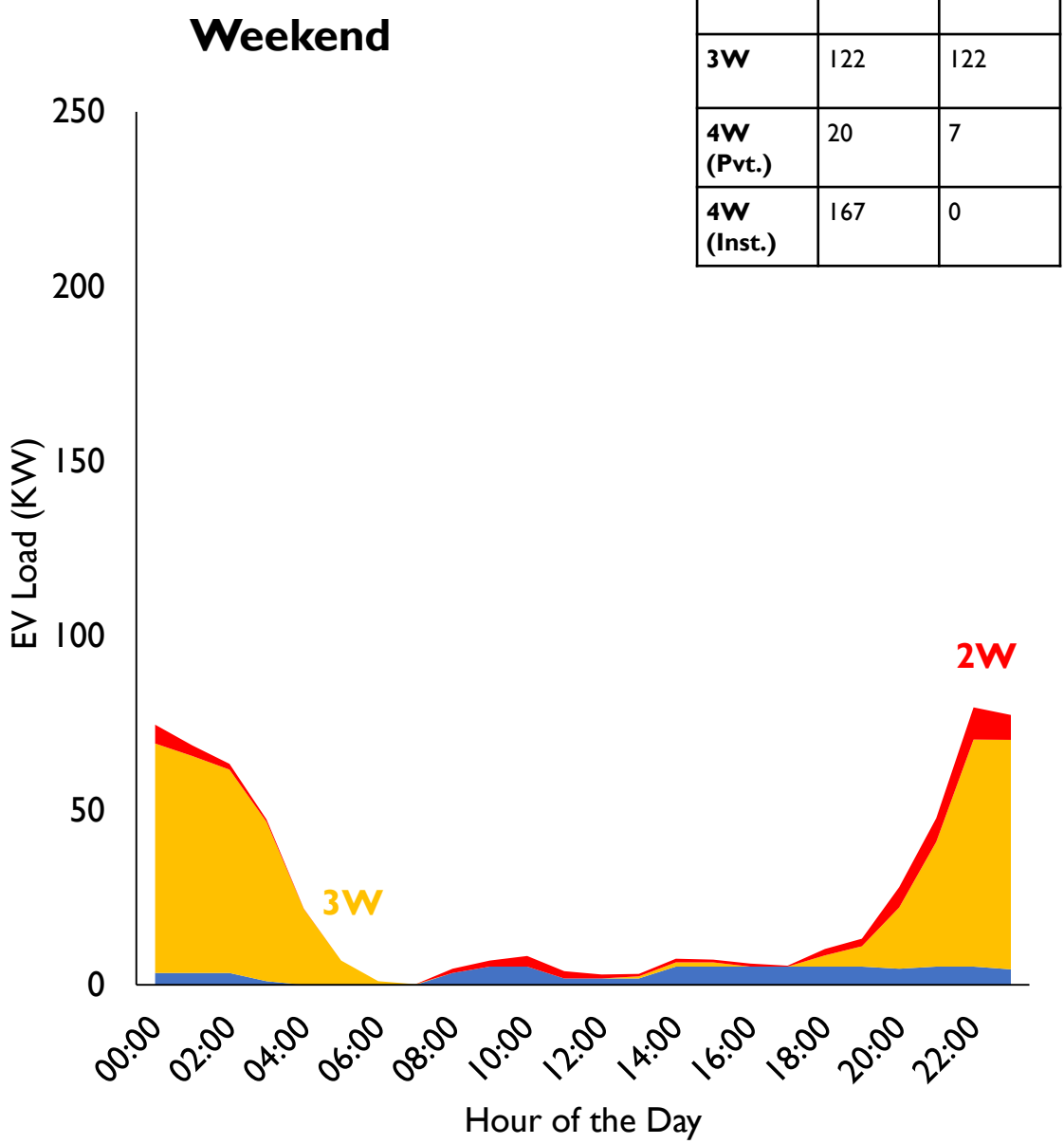
Impact due to **EV-4W(Institutional) moderate charging** on a **Weekday**



Combined Hourly Impact of EV's based on surveyed vehicles

No. of surveyed vehicles charging on		
	Weekday	Weekend
2W	123	56
3W	122	122
4W (Pvt.)	20	7
4W (Inst.)	167	0





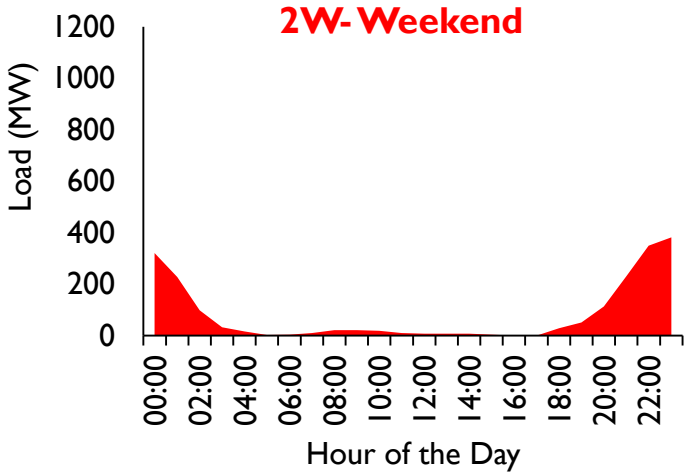
Impact of EV's in 2030 on the Grid (Delhi)

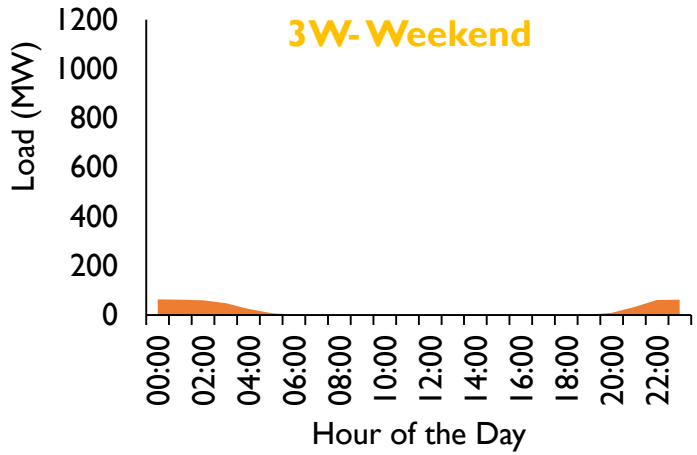
(EV's Count of 2030 estimated)

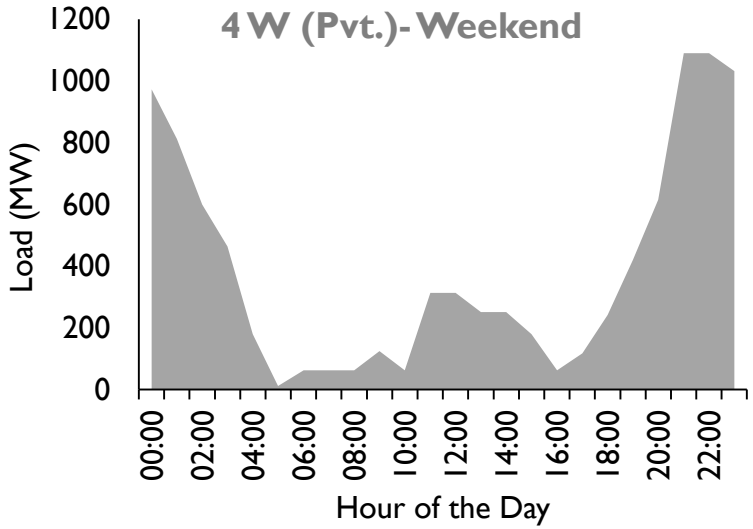
IRADe's Estimated Vehicle Count for 2030

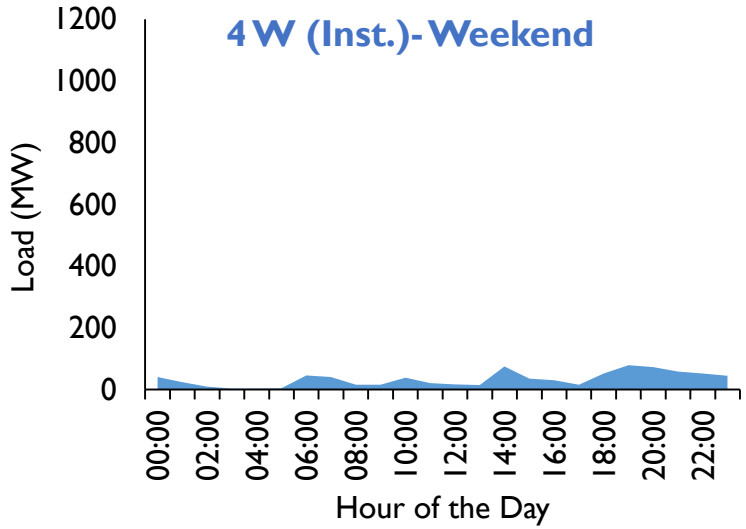
Sl. No.	Electric Vehicle Category	Vehicle Count in 2019-20 (% in total vehicle Count)	Estimated Count in 2030 (% in total vehicle Count)
1	EV-3W/ e-rickshaw	88,945 (100%)	1,20,013 (100%)
2	EV-2W	3,346 (0.1%)	14,93,632 (34%)
3	EV-4W (Private)	1,664 (0.08%)	6,97,935 (30%)
4	EV-4W (Institutional)	2,337 (2.25%)	51,862 (41%)

Source: IRADe Estimates

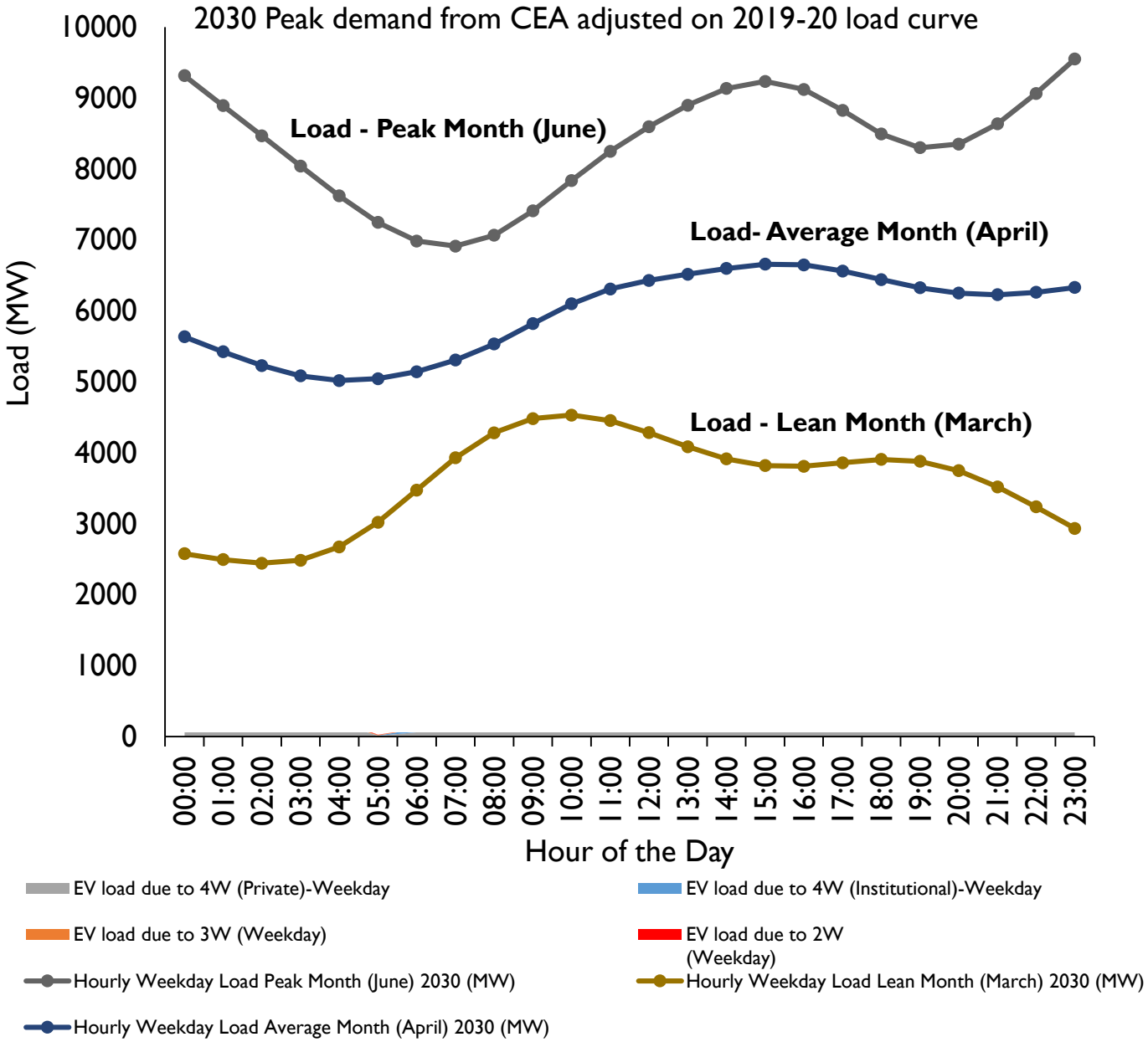


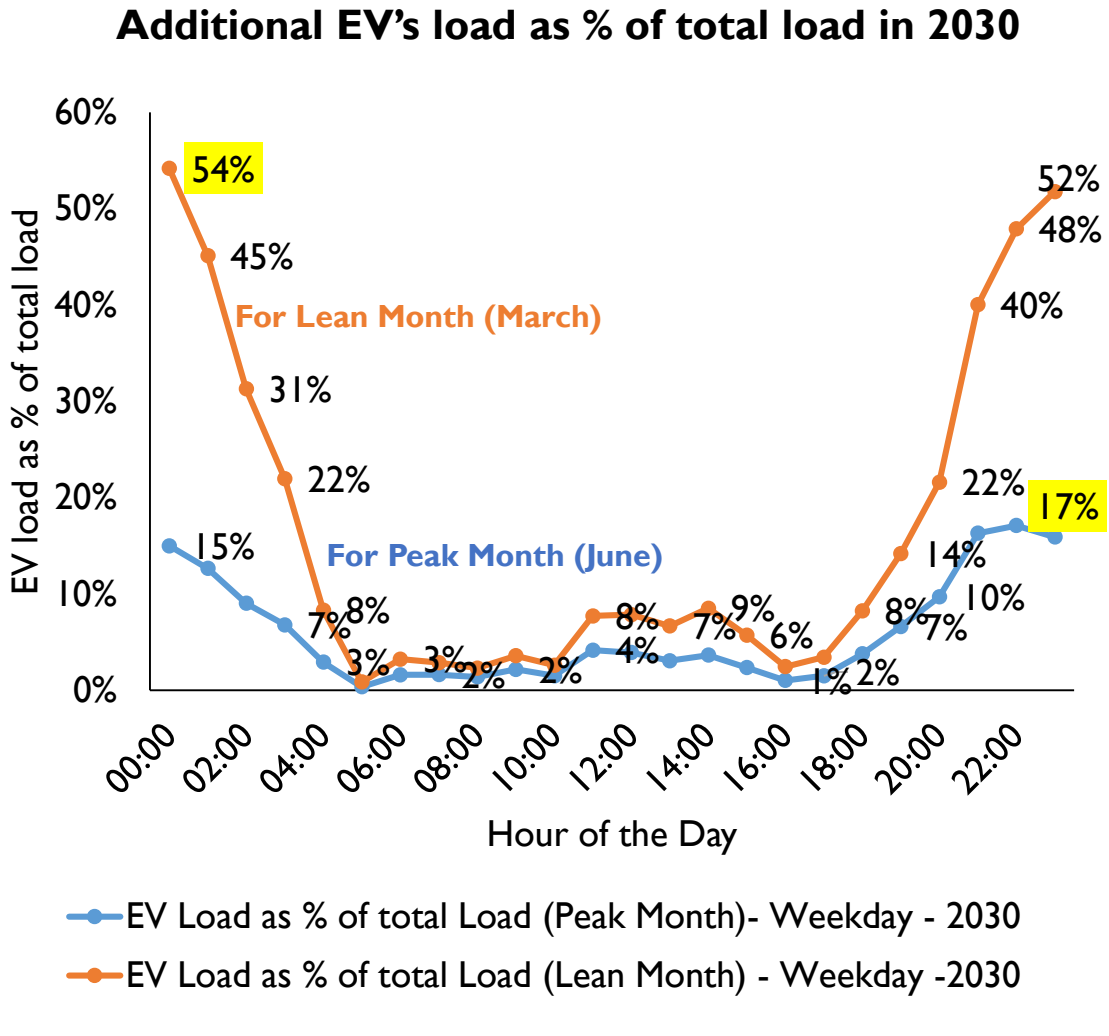






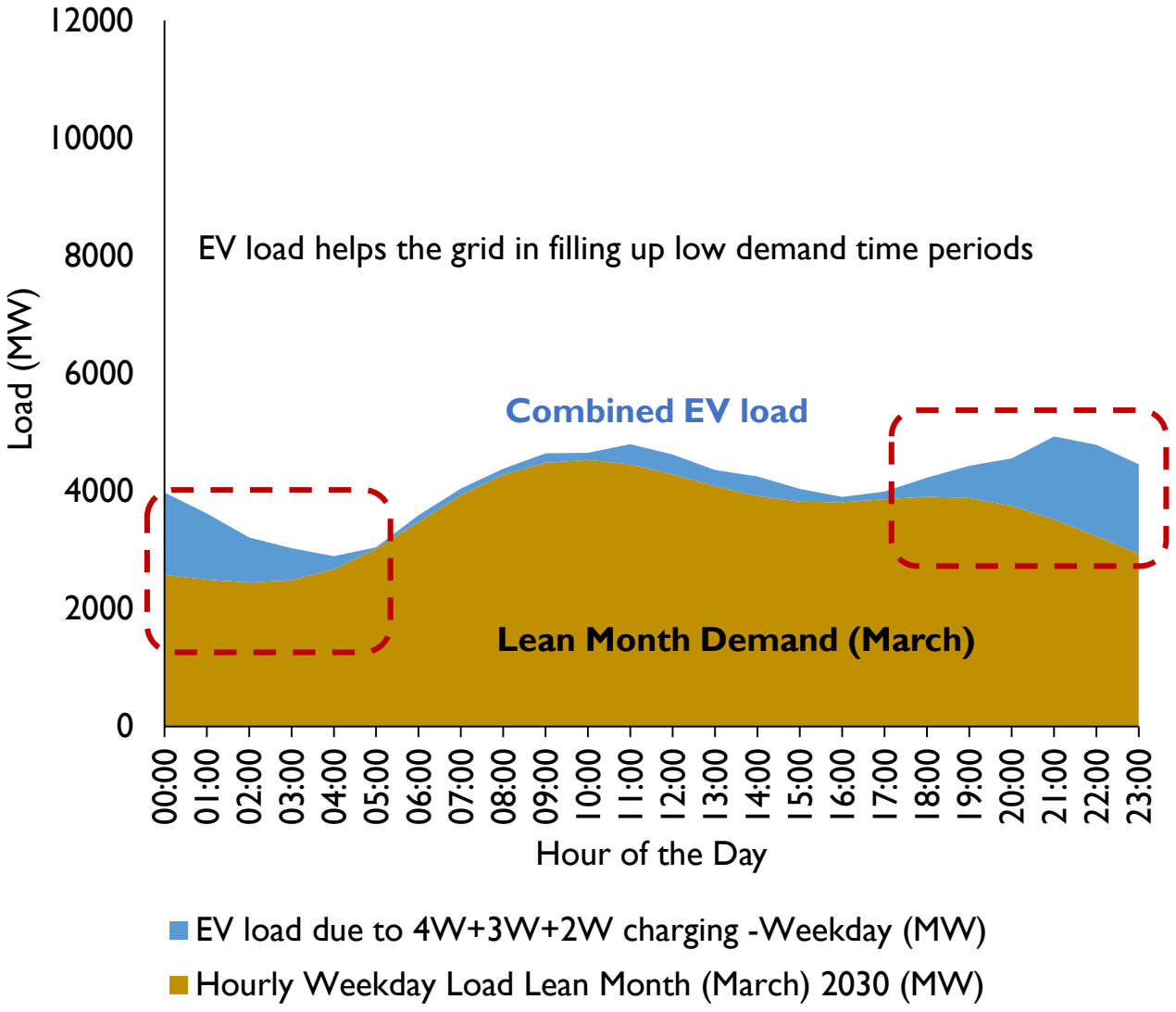
Impact of EVs on Delhi Grid on a Typical Weekday -2030



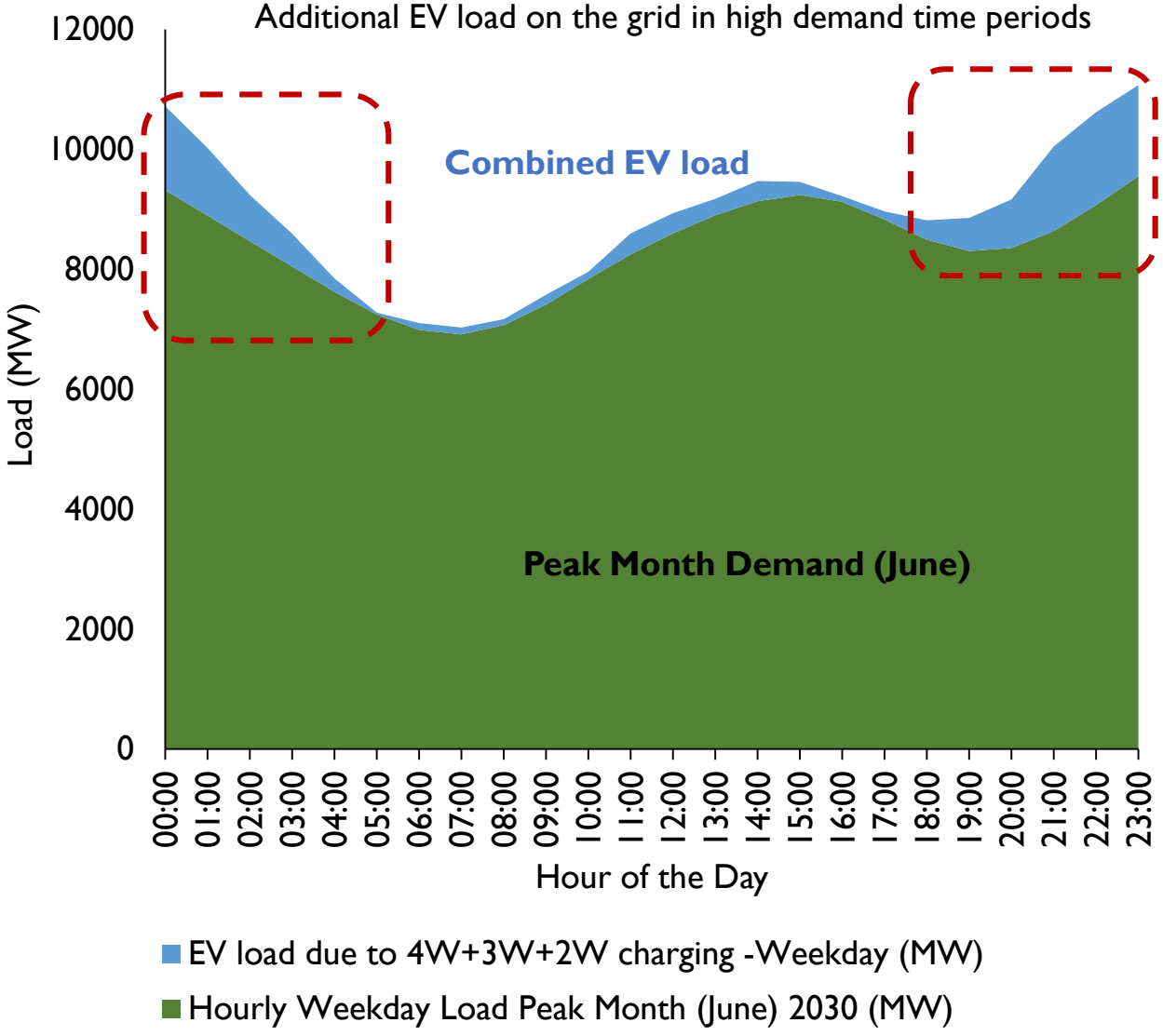


Impact of EVs on Delhi Grid on a Typical Weekday -2030

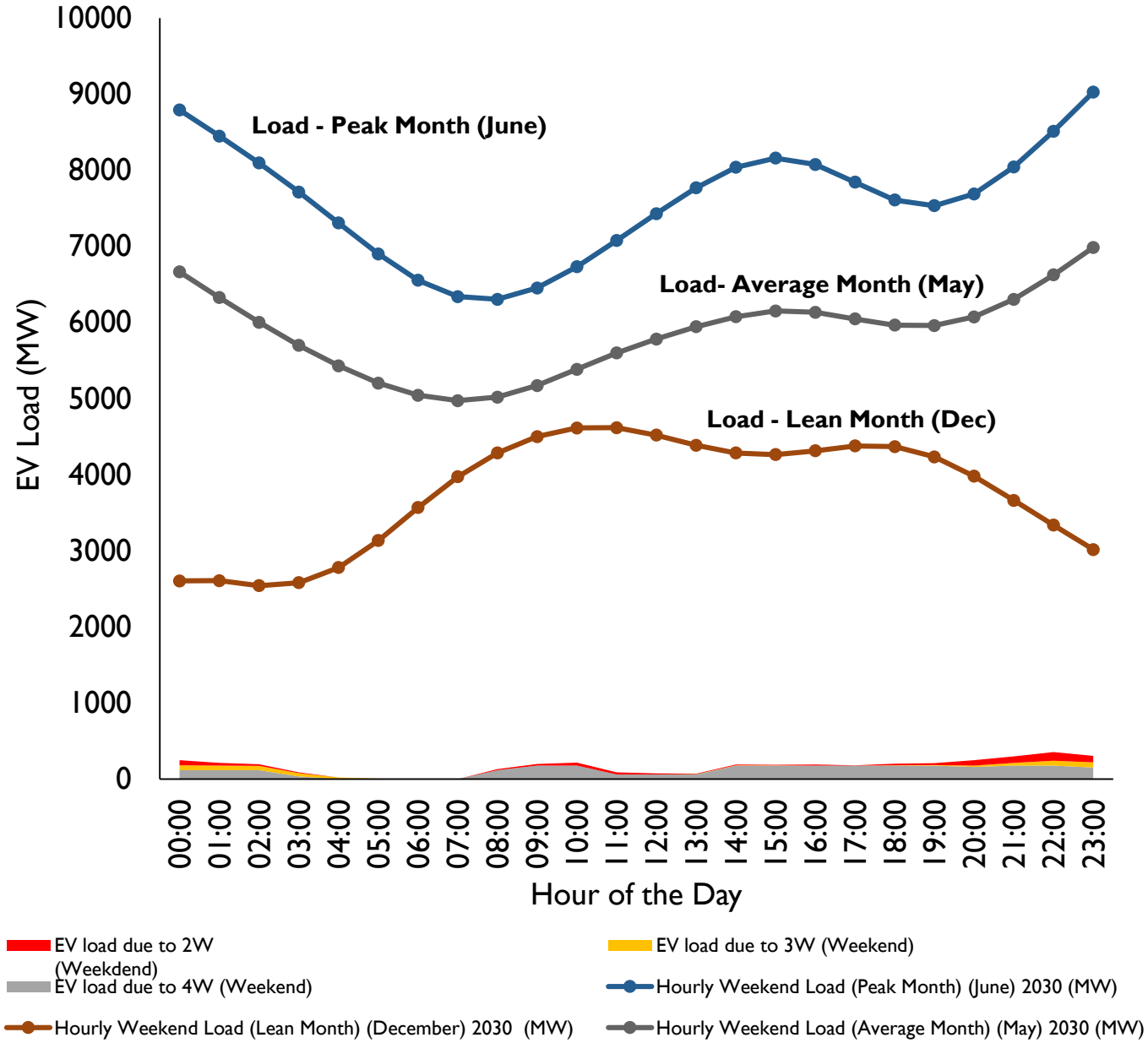
Combined EV Load + Lean Month Demand

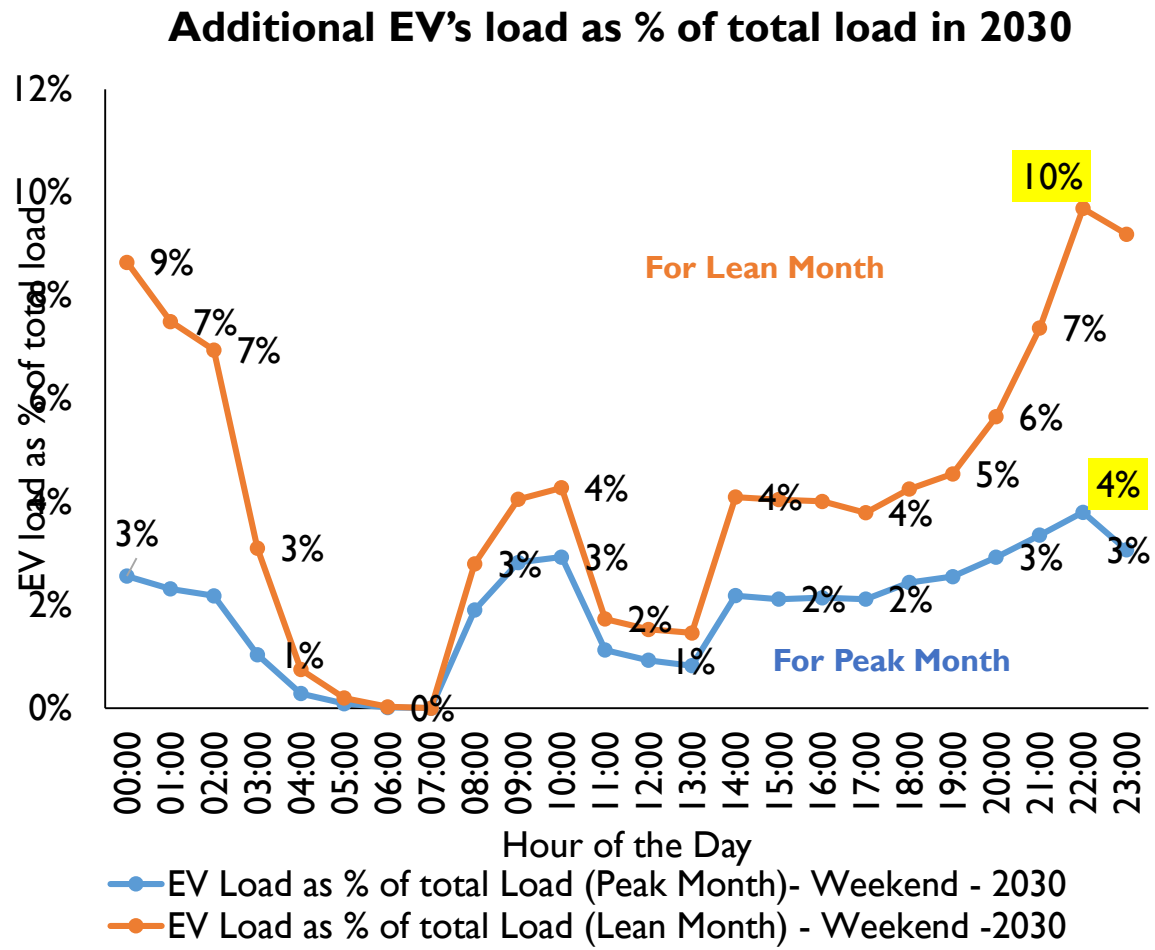


Combined EV Load + Peak Month Demand



Impact of EVs on Delhi Grid on a Typical Weekend -2030





Key Conclusions

- The impact of EVs in 2030 is profound and is provided below

  a. Additional EV Load share in 2030 estimated hourly Demand (without EV Load) on **weekdays**

  (i) Maximum of 17% at 00:00 HRS in **Peak month**

  (ii)Maximum of 54% at 22:00 HRS in **Lean month**

  b. Additional EV Load share in 2030 estimated hourly Demand (without EV Load) on **weekend**

  (i) Maximum of 4% at 00:00 HRS in **Peak month**

  (ii) Maximum of 10% at 22:00 HRS in **Lean month**

- The higher numbers of e-rickshaws is not adding much load on the grid because of the small size of batteries
- The impact of the noon charging peaks due to 4W-(Institutional) vehicles is substantially dampened because higher EV-4W private vehicles in 2030
- Policies for shifting charging time needs to be explored based on **Supply pattern of Electricity**
- **Sensitivity of Charging time with price of electricity** needs to be explored

Notes: The survey of the study is spanned over only two months (Sep-Oct 2020) and hence the seasonal variation in EV Charging behaviour, if any, does not show in the outputs.

Suggested Interventions for Load Management

Time of Day (ToD) Tariff:

- Using TOD, the surge loads of EV's in the noon and early evening hours can be shifted to off-peak hours of late-night by **utilizing ToD tariff for a price-sensitive consumer**.

Smart Charging/ Managed or Controlled Charging

- In Smart charging, charging can be initiated, stopped or regulated for an EV or multiple EVs based on **remote functionality**.
- Smart charging can be **unidirectional or bi-directional** (Vehicle to Grid).

IRADe's EV's Load Calculator (simplified version)

Data Entry for Load Calculator

2 Wheelers Input	
Total Electric Two Wheelers Count	1493632
Average Battery Capacity (Kwhr)	1.656
Average Time taken to charge from 0-100% (H	6.5

Share of different modes in 2 Whelers	Bikes	Scooty	Moped
Vehicle share	1%	99%	0%
Vehicle Count	14936	1478696	0
Average Battery capacity (kWhr)	1.656	1.656	1.656
Average Time taken to charge from 0-100% (Hrs)	6.5	6.5	6.5

3 Wheelers Input	
Battery Capacity (Ahr)	100
Charge Voltage (V)	48
Battery Capacity (Kwhr)	4.8
Time taken to charge from 0-100% (Hrs)	9
Charging Rate (kW/hr)	0.5
Total Count of Vehicles	120013

4 Wheelers (Private) Input	
Total Electric Four Wheelers Count	697935
Average Battery Capacity (Kwhr)	23
Average Time taken to charge from 0-100% (H	9

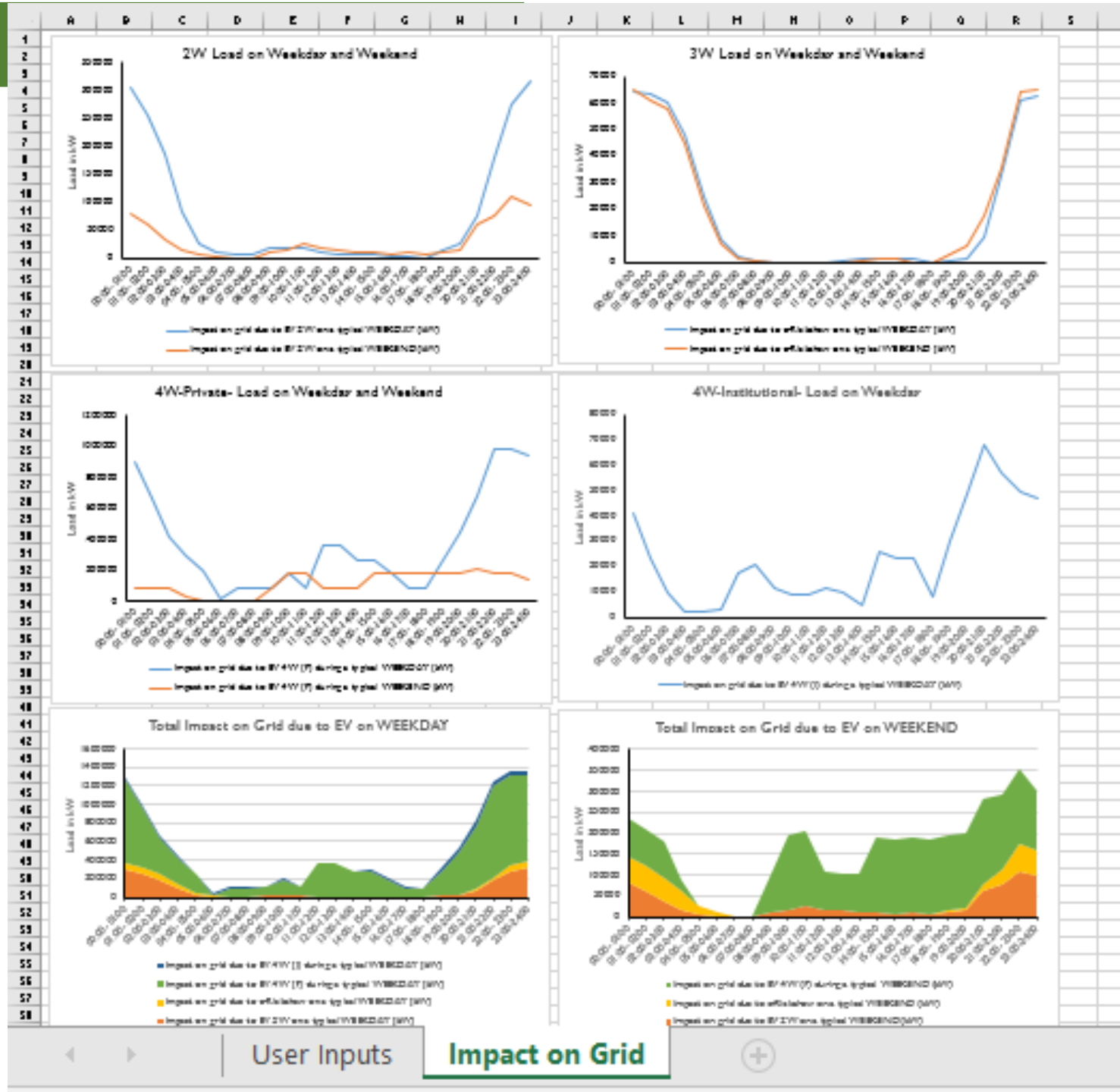
Share of different modes in 4 Whelers	Type 1	Type 2	Type 3	Type 4	Type 5
Vehicle share	1%	95%	1%	1%	2%
Vehicle Count	6979	663038	6979	6979	13959
Average Battery capacity (kWhr)	23	23	23	23	23
Average Time taken to charge from 0-100% (Hrs)	9	9	9	9	9

4 Wheelers (Institutional) Input	
Total Electric Four Wheelers Count	51862
Average Battery Capacity (Kwhr)	19
Average Time taken to charge from 0-100% (H	10

Share of different modes in 4 Whelers	Type 1	Type 2	Type 3	Type 4	Type 5
Vehicle share	1%	95%	1%	1%	2%
Vehicle Count	519	49268	519	519	1037
Average Battery capacity (kWhr)	19	19	19	19	19
Average Time taken to charge from 0-100% (Hrs)	10	10	10	10	10

Sample Outputs

To be available soon on our website



Thank You