Electric Vehicle Uptake and Charging:
the consumer perspective

Wednesday, 3rd February 2021

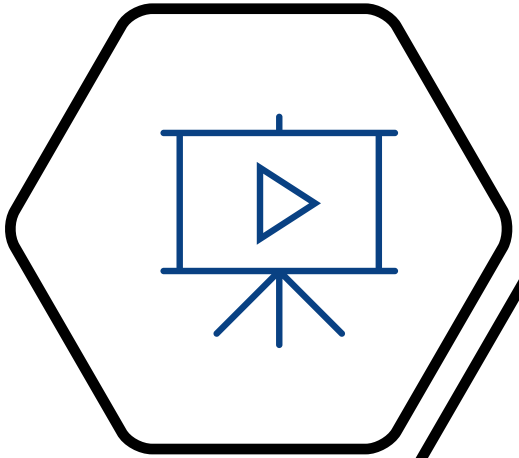
12:30 - 1:30pm AEDT

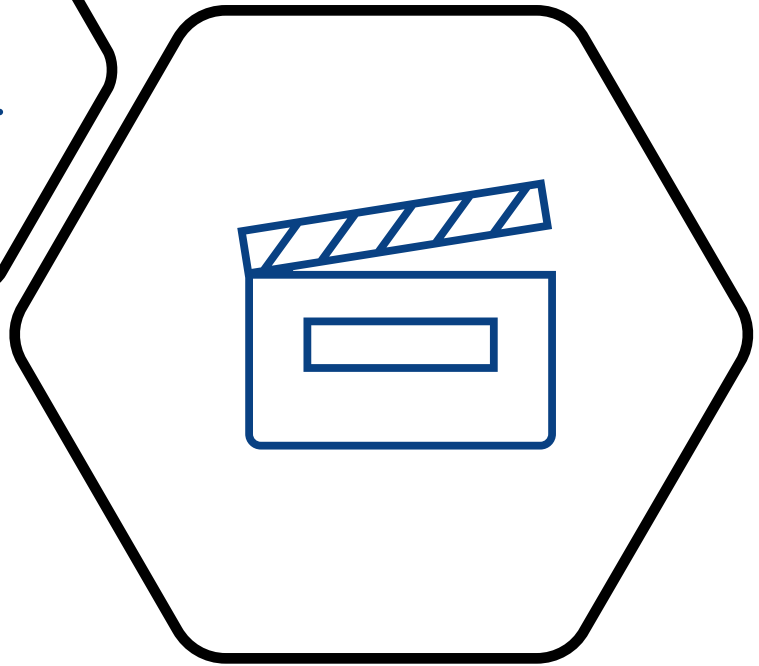
The Australian Power Institute

C4NET Centre for New Energy Technologies

Energy Networks Australia

The University of Melbourne





Please note this webinar is being recorded.

As we meet today,
connecting a diverse community of people from across Australia,
we acknowledge the traditional custodians of these lands,
and their continuing connection to land, waters and community.

We pay our respects to the people, the cultures and their elders past, present and emerging.

Australian Strategic Technology Program

Funding for energy network-related university research projects

The Australian Strategic Technology Program (ASTP) was set up primarily to provide funding for university research projects which have the potential to bring about improvements in asset management and network performance for electricity utilities, as well as exploring “non-network” solutions. The ATSP is a collaboration between Energy Networks Australia and the Australian Power Institute.

EV Integration Project (Sep 2020 – Sep 2022)

PROJECT SCOPE

The project explores four key research areas:

1. ***Customer acceptance and expectations around EVs*** (Report by Apr 2021)
2. Distribution network impacts from unmanaged EVs (Sep 2021)
3. Distribution network integration of EVs using active management strategies (Mar 2022)
4. Techno-economic network and system integration of EVs (Sep 2022)

The Australian Power Institute

C4NET Centre for New Energy Technologies

Energy Networks Australia

EV Integration Project (Sep 2020 – Sep 2022)

PROJECT TEAM

- Prof Pierluigi Mancarella (Techno-Economics)
- Prof Luis(Nando) Ochoa (Distribution Networks)
- **Dr Patricia Lavieri (Customers)**
- Prof Majid Sarvi (Transport)
- Dr William Nacmanson
- Dr Shariq Riaz
- Carmen Bas Domenech
- Data and know-how from DNSPs

Speaker

Dr Patricia Lavieri, Lecturer in Transport Engineering

- Travel behaviour and choice modelling
- Consumer interest, adoption, and use of new transport technologies and services
  - Connected and automated vehicles
  - Ride-hailing & ridesharing (e.g., Uber)
  - Bikesharing, e-bikes & e-scooters
  - Electric vehicles
- Impacts of ICTs and new transport technologies on travel demand and accessibility

Google Scholar

Webpage

Electric Vehicle Uptake and Charging: **the consumer perspective**

Webinar Goals

- Overview of consumer adoption and charging of EVs
  - FAQ
- Lessons from national and international projects and research
- Q&A

Global Uptake

2019

2.1 million sold
7.2 million stock

concentrated in
China, Europe & US

2.6% global car market
< 1% world stock

Highest penetration in
Norway with 13% and
56% of sales

SLOWDOWN IN SALES

- Car market contraction
  - Intensified by COVID19
- Reduction of purchase subsides
- Consumers are waiting for performance improvements and cost reductions

(Source: IEA, 2020. Global EV Outlook 2020: Entering the decade of electric drive?)

Local Uptake

Australia and New Zealand are part of the 20 countries with market share > 1%

AUSTRALIA

- 6,718 EVs sold in 2019
- 0.6% of total sales
- Fleet ≈ 23,000
- Steady increase in consumer interest
- NSW leads numbers while ACT leads %
- Pushing the market requires
  - Fuel efficiency standards
  - Consumer incentives
  - EV sales targets

NEW ZEALAND

- EV Fleet ≈ 20,000
  - Total feet 1/5 of Australia's
- Some incentives
  - exempt from paying road user charges until end-December 2021
  - lower ACC (a fund that covers the cost of accidents)
  - preferential parking
- Import of used short-range EVs (Nissan leaf)

WHAT INFLUENCES UPTAKE?

Types of EVs

Policies, Incentives & Regulation

DEFINITIONS

Charging Technology

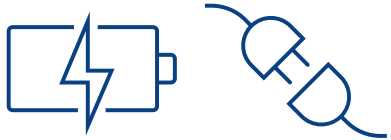
Types of Consumers

Charging Locations & Infrastructure

Types of EVs (electric cars)

~~Hybrid Car (NOT EV)~~

Plug-in Hybrid Car (PHEV)



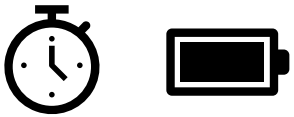
Plug-in Electric Car (PEV)

- **Short-range** (≈<250km)
- **Long-range** (≈≥250km)

Charging Technology

- Level (power output)
- Mode 1-4 (communication)
- Type of plug
  - including wireless

What is most relevant to the consumer?

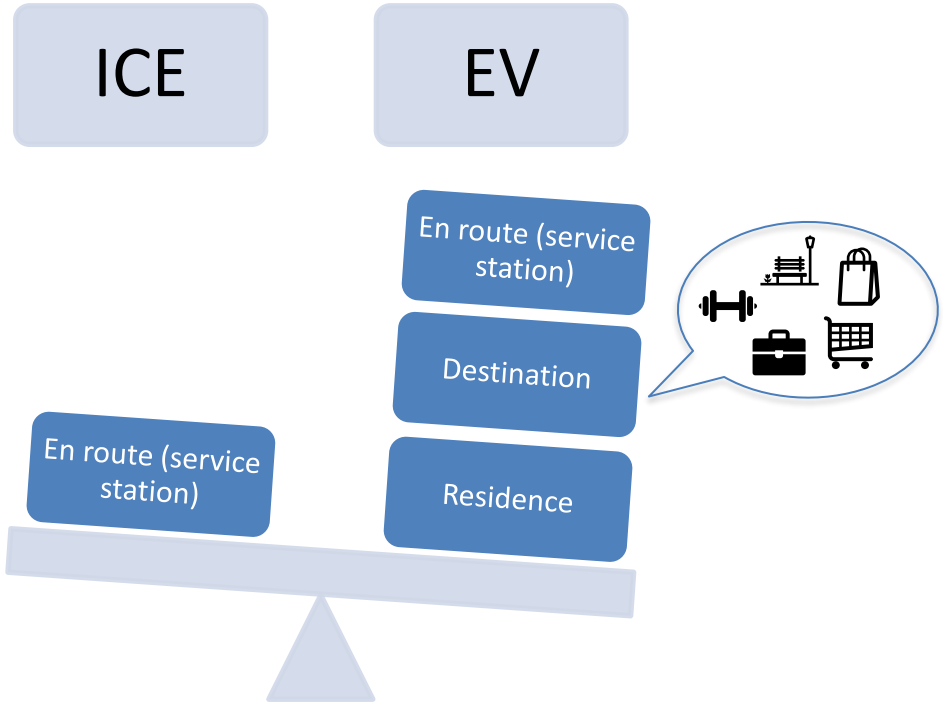


Charger Level	Charging Range Rate
Level 1 (AC 240V 1.4kW)	7.5 to 15 km/hour
Level 2 (AC 240V 3.3.-7.4kW)	18 to 40 km/hour
Level 2 Fast (AC 415V 11-22kW)	45 to 120 km/hour
Level 3 (DC 25-350kW)	150 km/hour to full charge < 10 min

Table 1: Charger levels and rate of charge.
Source: Adapted from EVSE (evse.com.au) and EVC (http://electricvehiclecouncil.com.au/about-ev/charger-map/)

Charging Locations

Behavioural change



Charging Infrastructure

Worldwide

7.3 million chargers

6.5 million in homes, multi-dwelling buildings, workplaces

598 000 public slow chargers

264 000 public fast chargers (81% China)

Australia

2,307 public charging stations;

357 are fast public charging stations

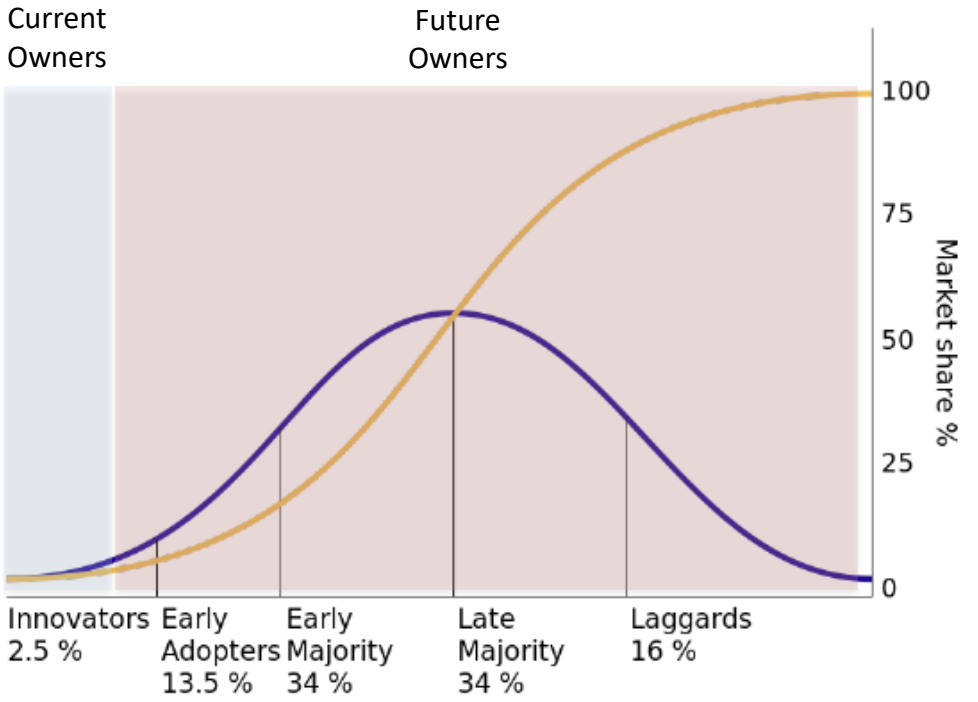
(+40% in a year)

1:9 station-EV ratio

Can be noticed by mainstream consumer?

(Source: IEA, 2020. Global EV Outlook 2020: Entering the decade of electric drive?; EVC, 2020. STATE OF ELECTRIC VEHICLES, August 2020)

Types of Consumers



Source: Based on Rogers, E., 1962. Diffusion of innovations. Free Press, London, NY, USA.

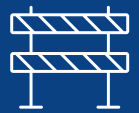
Figure 1: Diffusion of Innovations Curve.

- Risk takers with financial liquidity **vs.** practicality and $ driven consumers
  - Traits influence purchase but also use
  - Relevance of surveys with prospective owners
- Individual and household travel needs
  - Household composition
  - Location choices: residence, work, activities
  - Mode choice

Demographics of Current Owners

- Male
- High income & education
- Large household with multiple cars
- High annual distances travelled
- EV is main car

Motivations and Barriers to User Acceptance?

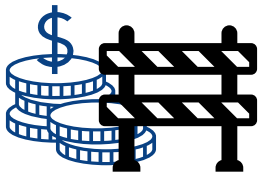


- Australian Prospective Buyers (EVC, 2020)
  - Motivations
    - Environmental footprint
    - Running costs
  - Barriers
    - Purchase cost
    - Inconvenience of recharging
    - Range anxiety
      - Access to charging
      - Driving range

PERCEPTIONS ARE SIMILAR WORLDWIDE

WHAT DO OWNERS THINK?

- Public charging not as important
- Charging at home more convenient than ICE refuelling
- Driving range is sufficient

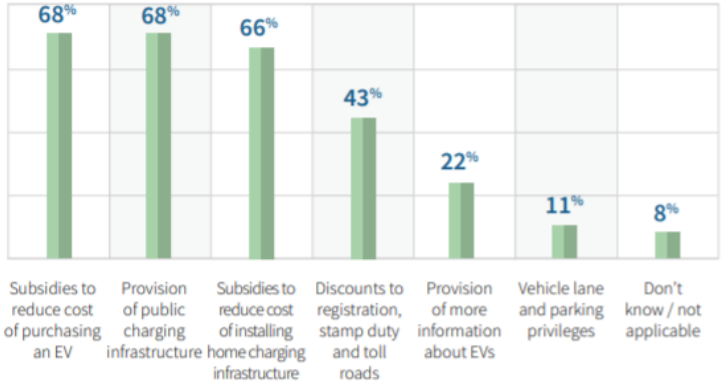


(Source: EVC, 2020. STATE OF ELECTRIC VEHICLES, August 2020)

What Policies, Incentives, and Regulations Most Influence Consumer Behaviour?

Australian Prospective Buyer Perception
(Source: EVC, 2020)

Government polices to encourage EV purchase



INTERNATIONAL EXPERIENCE?

- Multiple simultaneous incentives
- $ incentives preferred generating tangible immediate results (purchase cost and tax)
- Charging infrastructure has paid off in places such as Norway & China
  - Potential for 20% market increase in UK (Energeia, 2018)

…as uptake increases… are we ready for the charging demand?

Determinants and Dimensions of **Charging Decisions**

User & Household

Driving Patterns
Range of Battery
Home Charging Availability & Level
Range Anxiety & Charging Preferences

Market & Infrastructure

Public Charging Availability & Tariffs
Public Charging Location & Level
Policies & Incentives
Electricity Management Programs

Charging Decisions

Charging Location
Charging Level & Duration
Charging Frequency
Charging Time

Where Do Users Prefer to Charge?

50-90% charging events*

for commuters,
15-40% charging events*

» *followed by workplace, and then supermarkets/shopping facilities*
  – *Destinations are preferred over service stations*

» *Level 2 residential charging increase associated with long-range EV growth*

» *home charging is concentrated both in time and space*

» *different consumer groups prioritise time, money, and convenience differently*
  – *Growth in trade: residential by free destination charging when looking for $$ savings*

(*Idaho National Laboratory, 2015; National Research Council, 2015; Hardman et al., 2018; Funke et al., 2019; Fleetcarma, 2020)

How to Determine the Potential for Residential Charging?

- *Home charging usually requires off-street parking and parking spot proximity to electrical outlet*
  - *Less likely in apartment buildings*
  - *If no information about parking, dwelling type is the used proxy*
    - *Detached houses 4x more likely to have access to charging than apartments (Axsen and Kuran, 2012)*
  - *Residential density (simpler proxy)*
- *Home owners more likely to install Level 2*

Potential Access to Residential Charging: **the Case of Victoria**

Location	Number of dwellings	Number of detached/semi-detached houses	Number of houses with potential for Level 1 charging	Percentage of dwellings with potential for Level 1 charging	Number of houses with potential for Level 2 charging	Percentage of dwellings with potential for Level 2 charging
	(A)	(B)	(C)	(D)	(E)	(F)
	Data		Estimates			
(1) Inner Melbourne	76,790	11,979	8,110	10.6	2,709	3.5
(2) Greater Melbourne and Greater Geelong	1,599,533	1,407,589	1,407,589	88.0	1,059,915	66.2
(3) Remainder of Victoria	448,549	432,401	432,401	96.4	324,461	76.3
(4) All Victoria	2,124,872	1,851,970	1,848,100	**87.0**	1,405,085	**66.1**

Potential for Exclusive Residential Charging: **the Case of Victoria**

Total daily distance travelled (km)	Per person		Per household		Per vehicle
	All modes	Car only	All modes	Car only	Car only
Average	45.7	40.4	105.4	88.9	66.3
25th percentile	8.1	8.9	16.0	17.7	13.2
50th percentile (median)	20.4	21.4	46.8	45.2	32.1
75th percentile	46.3	46.3	103.1	102.2	72.0
90th percentile	84.7	86.5	187.6	185.1	144.0
95th percentile	115.9	121.4	264.1	267.6	208.6
99th percentile	266.3	238.3	585.7	548.5	483.4

9 out of 10 people travel 86.5 km or less by car per day

- Considering
  - 200km EV range
  - 87% residential charging potential
  - Usual travel
- ≈ 78% households could charge only at home

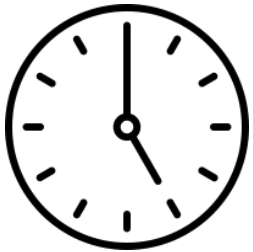
Charging Durations and Frequencies?

» *Indicates habitual behaviour rather than "empty-to-full"*

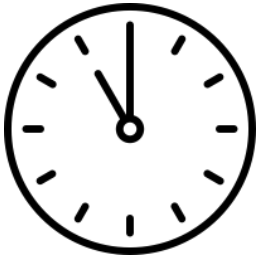
» *Increase in penetration of long-range EVs may change pattern*

Charging sessions using Level 3 chargers are usually shorter than 30 minutes. Indeed, longer sessions in Level 3 public chargers might be inefficient since charging rates decrease with the increase of SOC.

When do Users Charge?



No management = after work charging



Time-of-Use tariffs = second peak

local peaks accentuated by the uneven spatial distribution of EV ownership

Managed Charging: **types, acceptance, and effectiveness?**

» *Users tend to prefer managed charging because of $ savings*

TYPES

» *User managed **vs**. system managed*

» *Fixed ToU tariffs **vs**. dynamic pricing*

» *Reward system **vs.** actual $ savings*

Electric Nation Smart Charging Trial (UK)

- App Trip plans ☒
- App choice for save mode or immediate charge mode ☑

EFFECTIVENESS

» *Initial adhesion is main challenge (trials **vs.** reality)*

» *6:1 ratio of peak and off-peak prices to attract consumers (Idaho National Laboratory, 2015*

What About Fast Public Charging Important?

…associated to overall increase in electric vehicle kilometres travelled (eVKT)

WHERE

» *if home charging is common, in **long-distance travel corridors***

» *in **very dense urban areas,** where there is low home charging availability*

– ***CAUTION:** should not encourage private vehicle usage in dense areas served by mass transport*

» *proximity to fast public charging **can increase users' acceptance** of diminished control over residential charging (increase acceptance of centralised **smart charging**)*

WHEN DEMAND INCREASES…

» *parking and tariff structure can play an import role in promoting **efficient use of fast public charging infrastructure (≤ 30 min)***

– *Station hogging associated to tariff structure*

– *free, only parking $, flat tariff without enforcement to move vehicle*

UPTAKE SUMMARY

- Australian consumers are aware of EVs and there is an increase in purchase interest.
- While EV sales are gradually growing, ICE sales have started to decrease.
- Increased EV affordability coupled with technological improvements in range capability is likely to accelerate the transition “tipping point”.

Yet, $$ incentives can bump up acceleration…

- Anticipated lack of access to efficient public charging stations or home charging is a significant barrier to EV purchase.
- However, as consumers become more familiar with and educated about EVs, the less they perceive public charging infrastructure and EV range as a purchase barrier.
- EV users usually find home charging more convenient than refuelling ICE vehicles at petrol stations.

Mainstream consumers underestimate vehicle range and overestimate need for public charging: Need for public awareness initiatives

IMPLICATIONS FOR NETWORK

- Since Australia's developing EV market is likely to have long-range EVs as the standard, facilitated installation of Level 2 home charging should be considered together with potential impacts on the grid.
    - Public and free charging can be used to manage electricity demand spatially.
        - Long-range EVs and solar panel owners more likely to charge only at home – will it balance out?
            - Parking rules and enforcement together with tariff structure can play an important role in preventing congestion and underutilisation of public (fast) charging infrastructure.
                - There is a need for empirical evidence on user preference and response to more complex charging tariff structures and dynamic pricing.

NEXT STEPS

ONLINE SURVEY

TARGET: 1000 AUSTRALIAN AUTO OWNERS

1. Potential for EV home & workplace charging
2. Potential for solar power use
3. Where and when do current EV owners charge their vehicles? What are the main attributes considered in the charging decision?
4. Adoption of centralised smart-charging systems
5. Preferred payment structure for public charging

Q&A

Do you agree with NZ approach on road user charging i.e. exempt for EVs for an initial time period?

How much do you think the question of range impacts consumer behaviour?

As technology evolves and users experience product range anxiety decreases. Matter of improving consumer knowledge.

Based on the research findings, will consumers accept having their charging managed and under what circumstances?

Better in practice than on paper

What are the demographic indicators for successful uptake? How to tackle the equity issue associated with higher capital costs?

How will the issue of charging be addressed in inner suburban electorates which only have access to on-street parking?

In London, street charging points are being installed in lamp posts next to parking bays. Australian city councils are still working to develop on-street charging solutions (AEMC, 2020; Milligan, 2018; REVWG, 2018).

Preferences between PEVs and PHEVs?

PEVs sales increasing (+14%)

PHEVs decreasing (-10%) globally

What have been the most effective government incentives or policies you've seen in international examples?

To trigger early adoption: purchase subsides and tax incentives

THANK YOU

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SELECTED REFERENCES

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(complete list in report)

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