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Electric Vehicles and V2G Integration in Future Grids

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Electric Vehicles

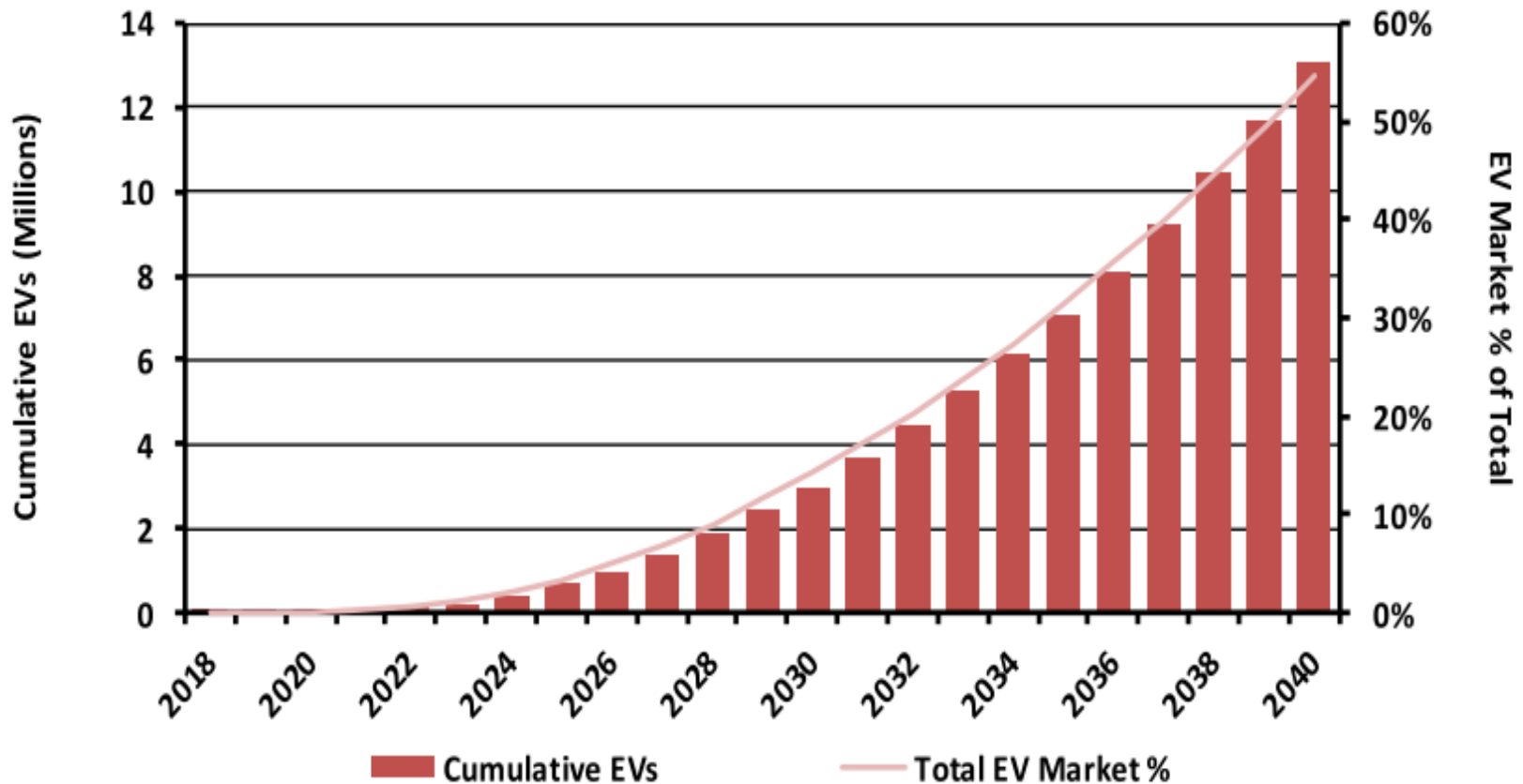
TESLA.COM/CYBERTRUCK



Image:Ringo H.W. Chiu/AP

EV predicted growth Australia - Cars

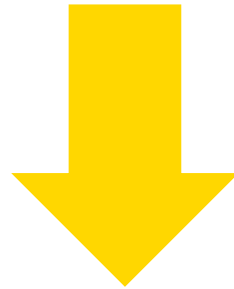
- 55% of total market share by 2040



How will EVs impact the grid?

Two initial main impacts:

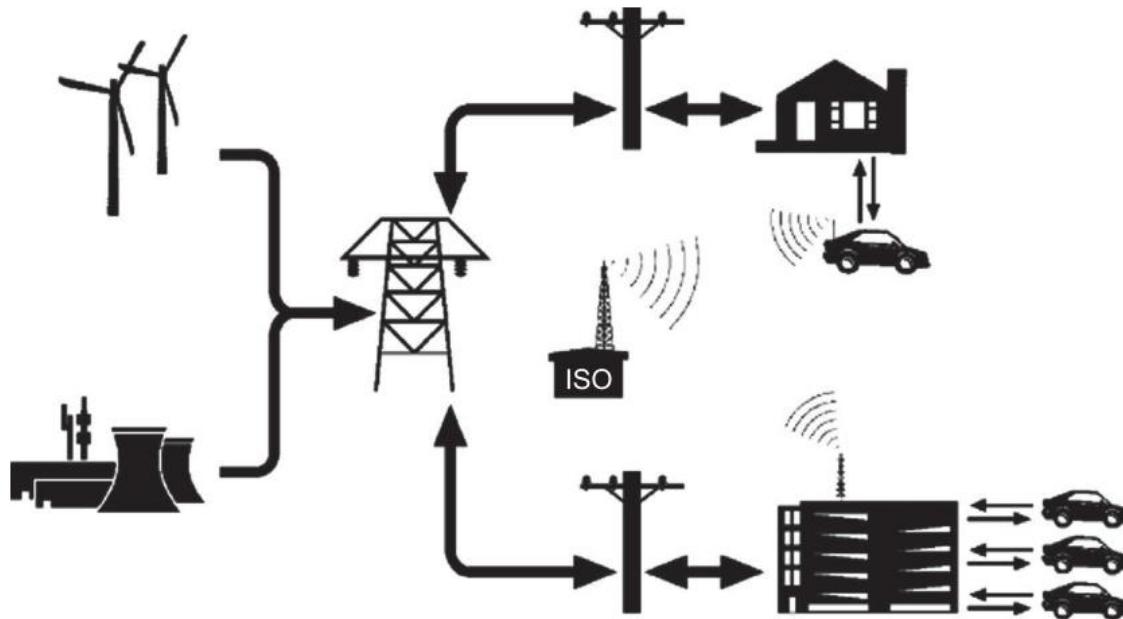
1. Generation - additional electricity generation requirements to meet EV load and
2. Network (distribution) - additional load in the distribution networks which might require network augmentation



Influenced by driving and charging patterns

Electric Vehicles and V2G

- Vehicle To Grid (V2G)
 - EV battery's discharge and providing important grid services while parked.
 - Additional means of utilising asset



How do we evaluate the impact of EVs?

EV load Profile

Goal:

- EV charging profile
- EV V2G availability

Limitations:

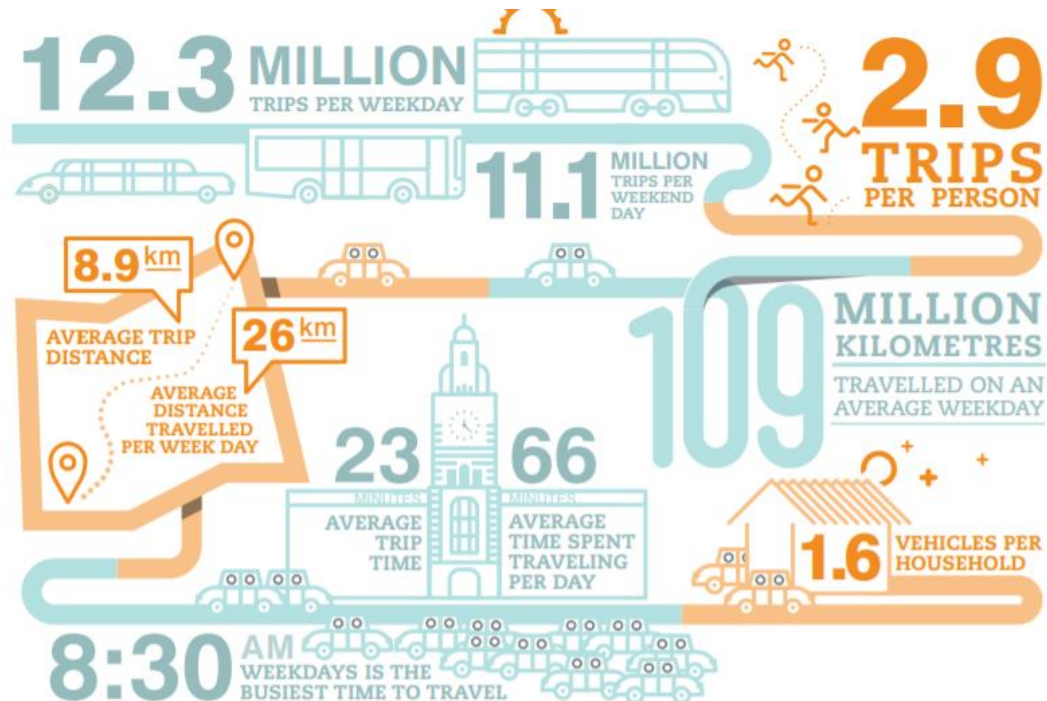
- Limited EV data for Australia due to slow uptake

Methodology:

- Victorian Integrated Survey of Travel and Activity – VISTA (2012-2016)
- Python
- Simulate SOC, charging times and V2G availability

VISTA data

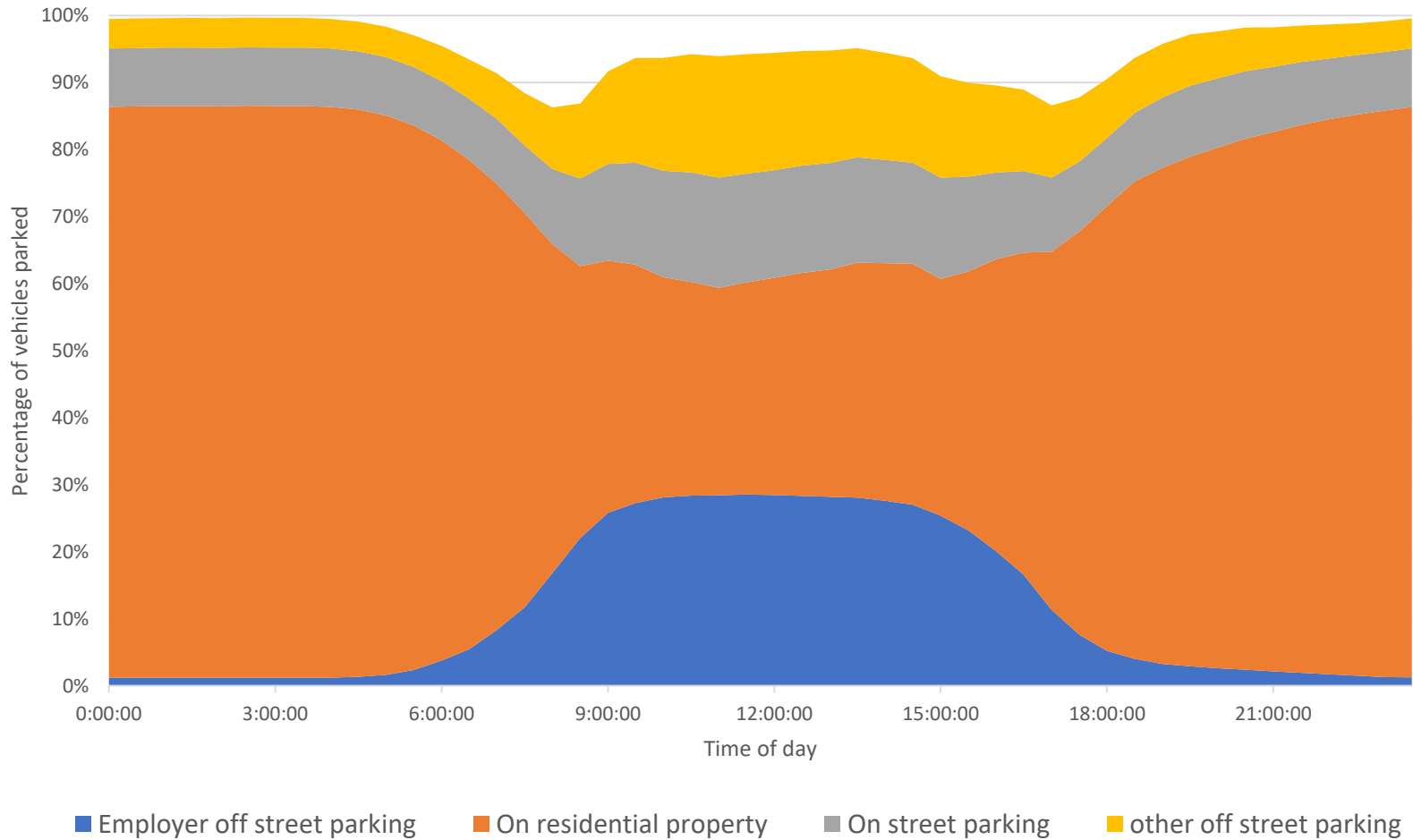
- 18,152 households from Melbourne and surrounding suburbs
- 15,000 individual trips
- Detailed parking location
- Residential commuters only – cars, 4wd, van, ute



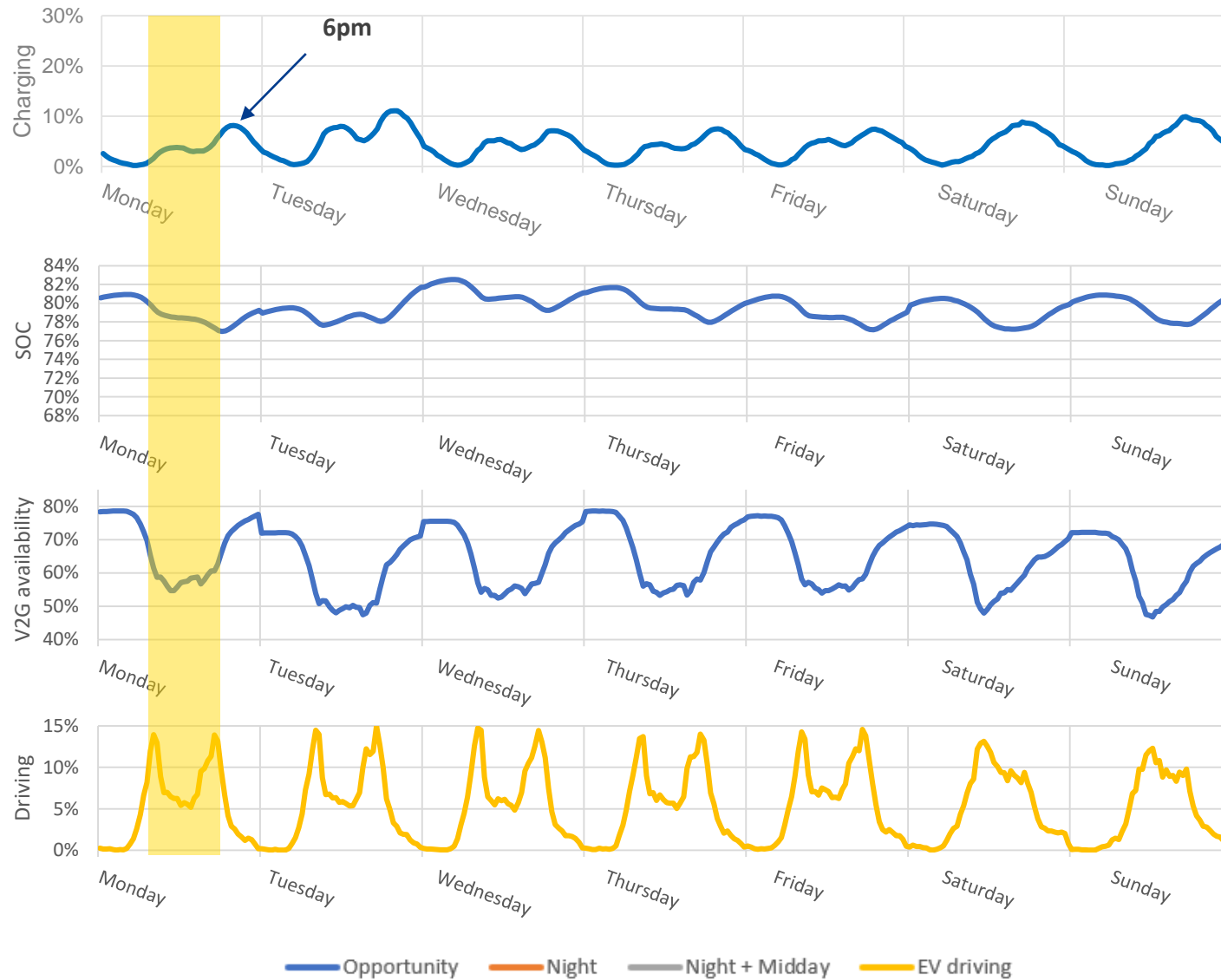
Modelling – EV Parameters

EV parameters		
Electric vehicle	Tesla Model 3	
Battery roundtrip efficiency	0.85	(Schäuble et al., 2017)
Fuel economy (kWh/km)	0.2	(IEA, 2018)
Battery capacity (kWh)	75	
Charging rate (level 2) (kW)	6.6	(Dunckley and Alexander, 2018)
Charging locations	Dedicated (off street) parking at home or work	
Charging limitation	Only start charging when battery SOC < 60% ₁	
Charging Scenarios		
Opportunity	Charging when possible	
Night only	Charging limited to 10pm-7am time block	
Night + Midday	Charging limited to 10pm-3pm time block	

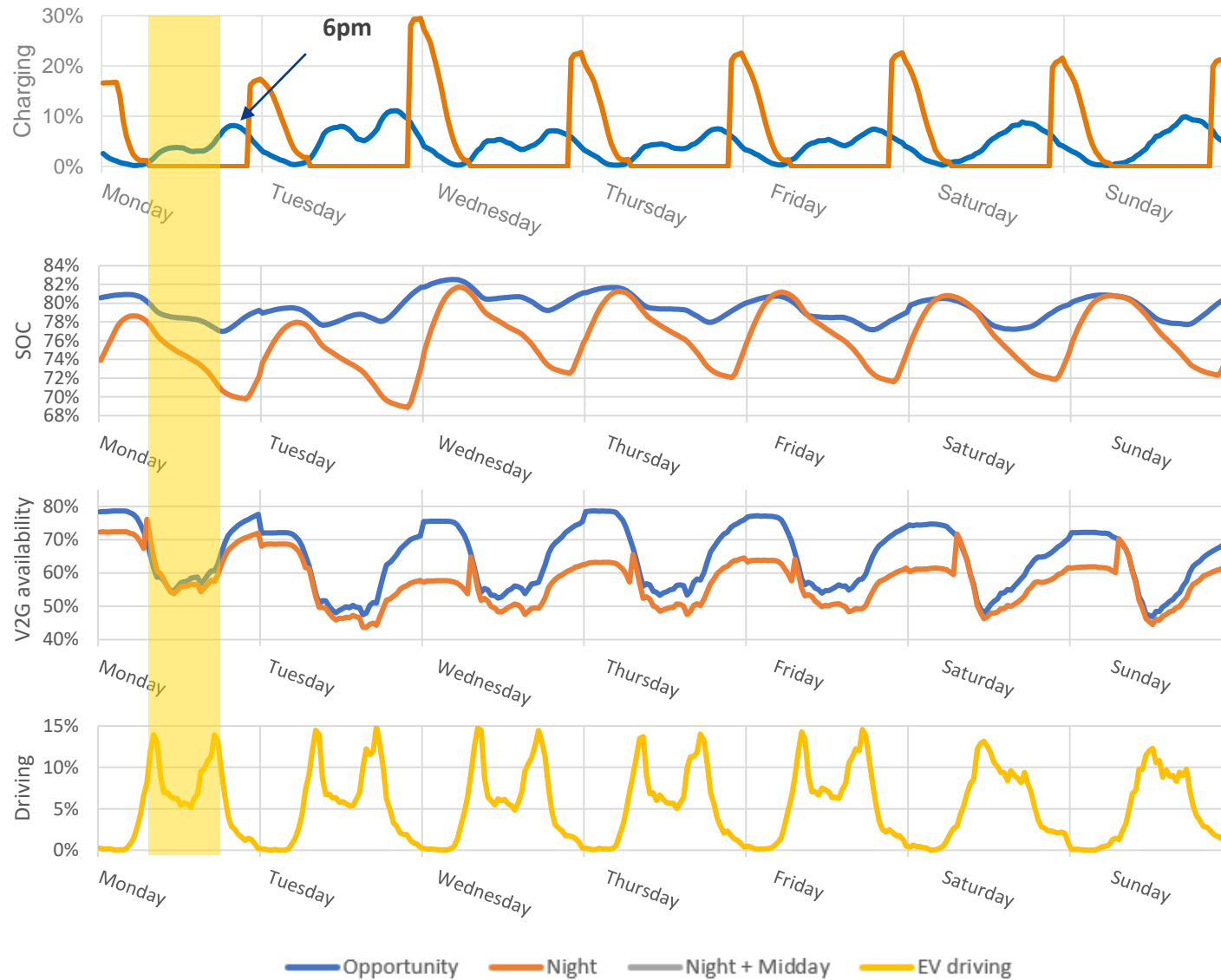
Initial VISTA data observations - Residential parking



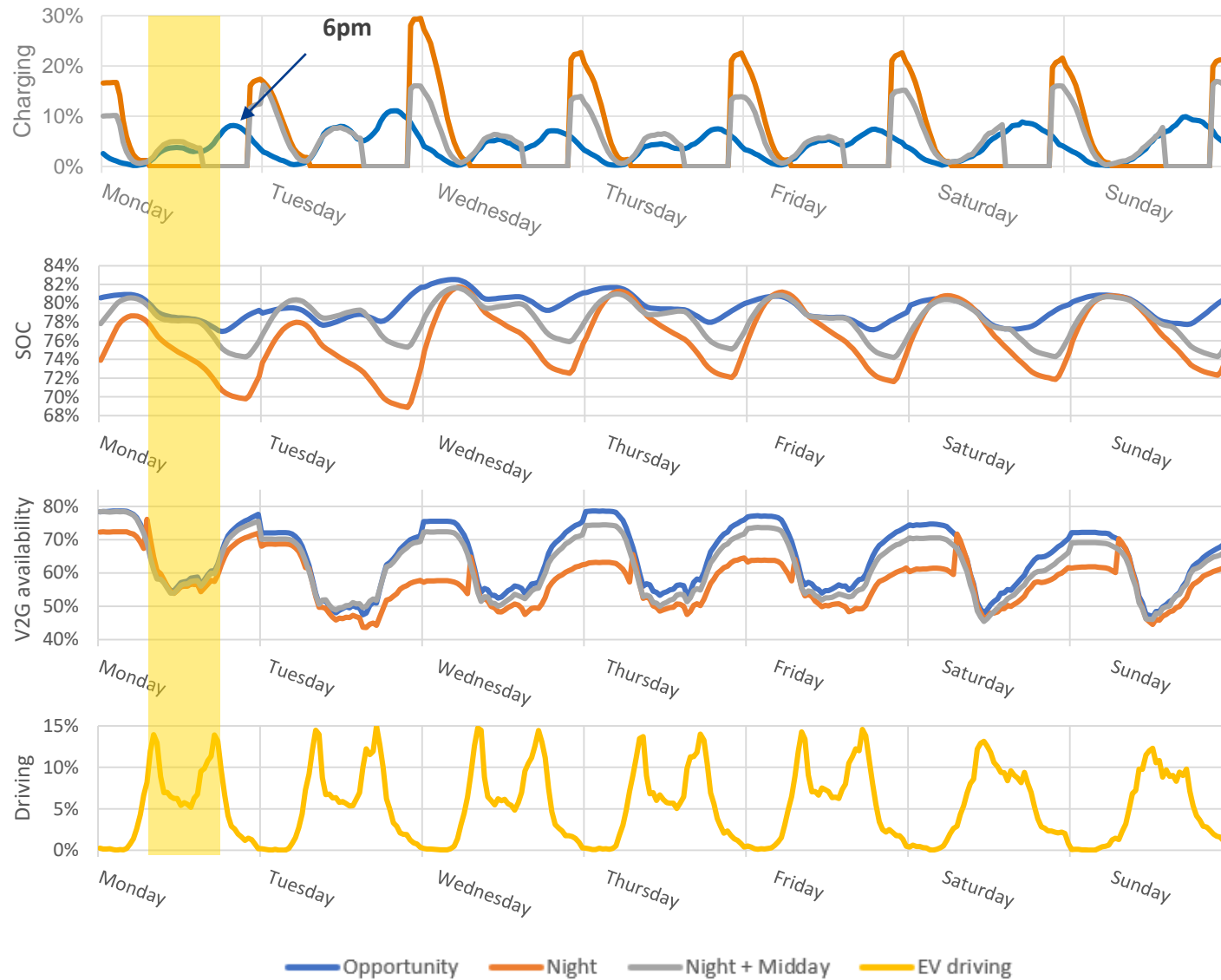
Simulation results



Simulation results



Simulation results



Simulation results

- **Urban commute impact on EV batteries** – Urban commute uses a small portion of EV battery average SOC remaining between 70-80% allowing for further flexibility of EV use.
- **Midday Charging** – Charging stations at work important to reduce peaks and improve V2G availability
- **Opportunity charging** - Opportunity charging simulations show peak in EV load charging at times of current residential peak. However, a fairly small proportion 10% are charging at peak time.
- **Night charging** – Night only charging creates a large peak at night time which can present a challenge at higher EV penetrations

Conclusion

A current day residential EV load profile for Australia was generated:

- Can be used in grid modelling
- Inform on potential conflicts with grid demand
- Impacts of tariffs on EV load and V2G availability

Future work:

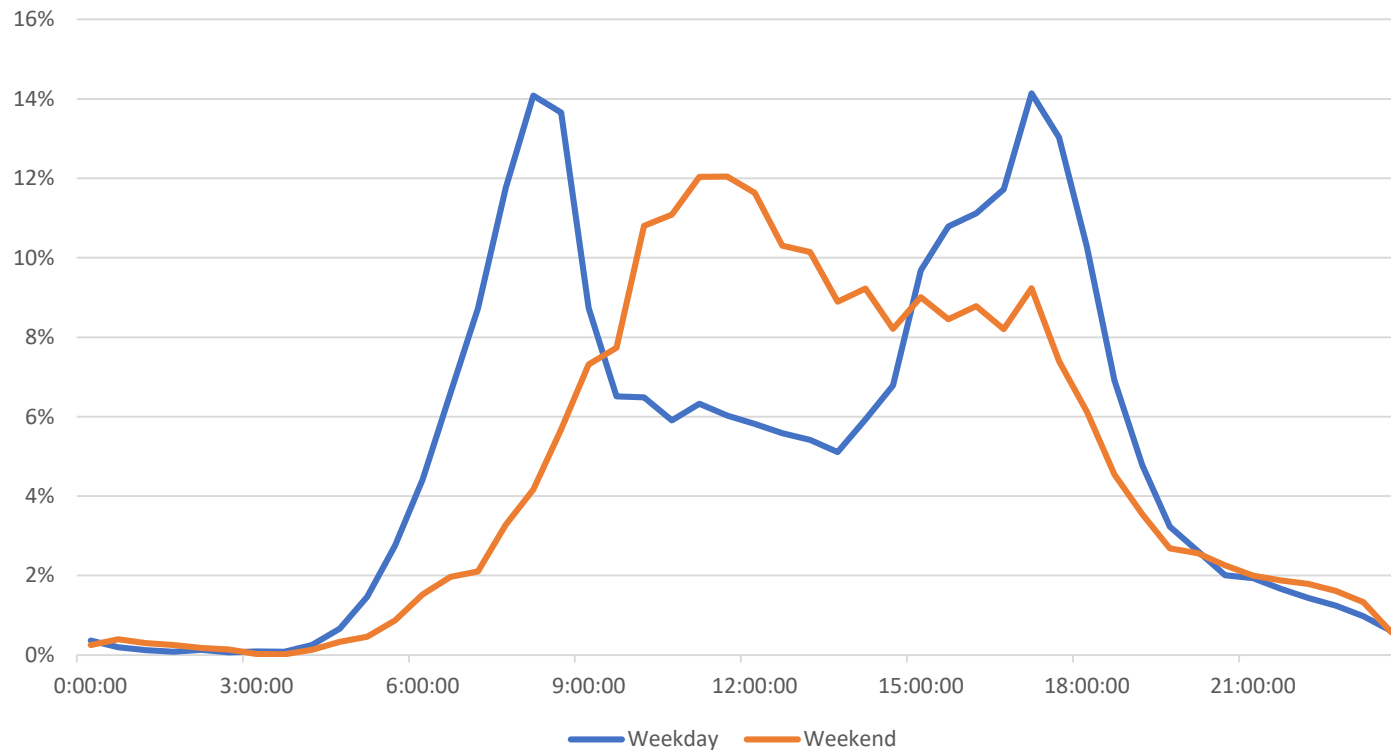
- Model EV profile in microgrid environment using openCEM and NEMO

Questions?

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VISTA weekday and weekend travel profile

- Double peak profile (weekdays)
- Maximum 14% vehicles traveling at a given time
- Weekday evening peak between 5-6 slightly before residential demand peak



Average travel pattern