

Assessing the potential impacts of electric vehicles on the electricity distribution network

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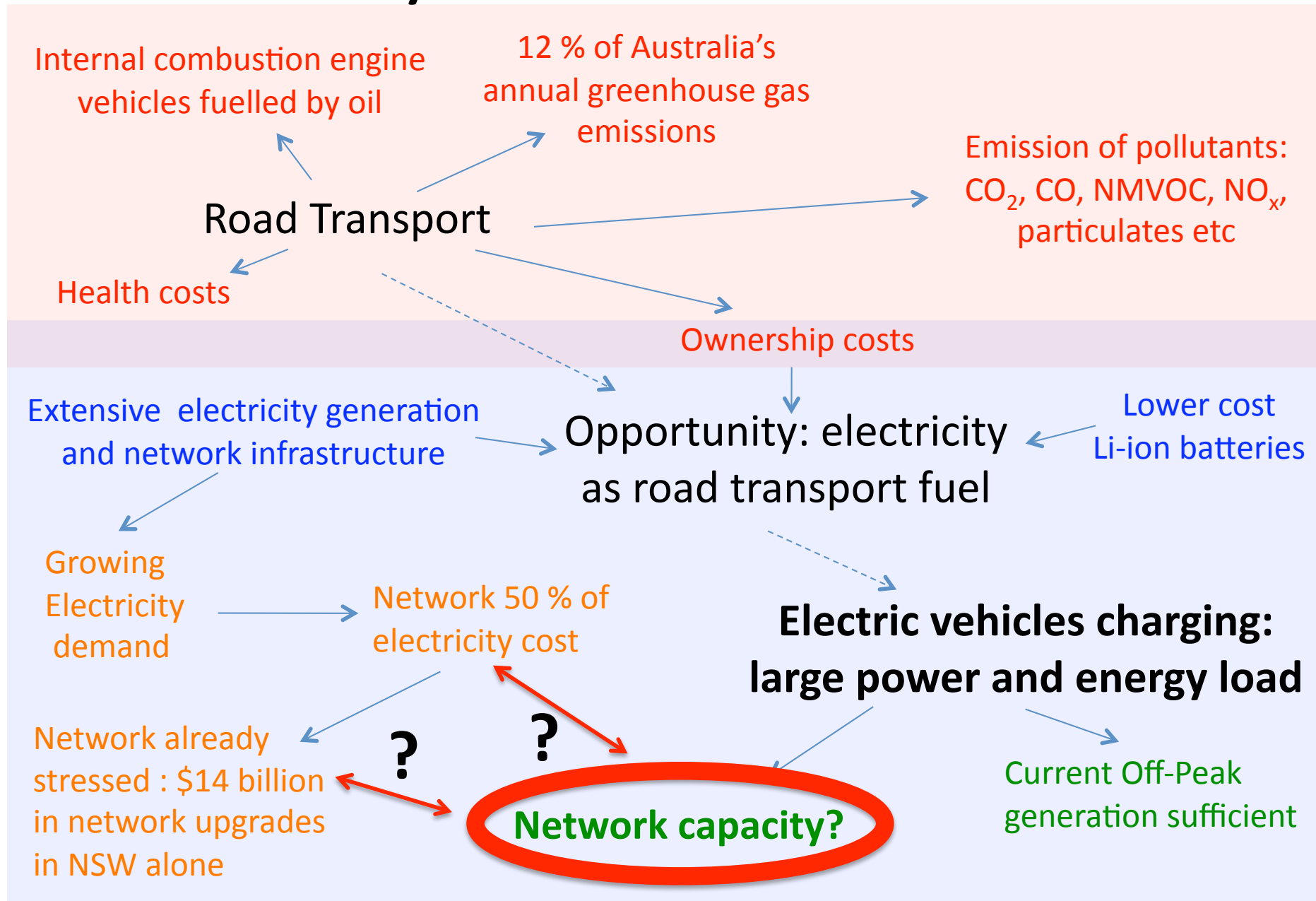
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Outline

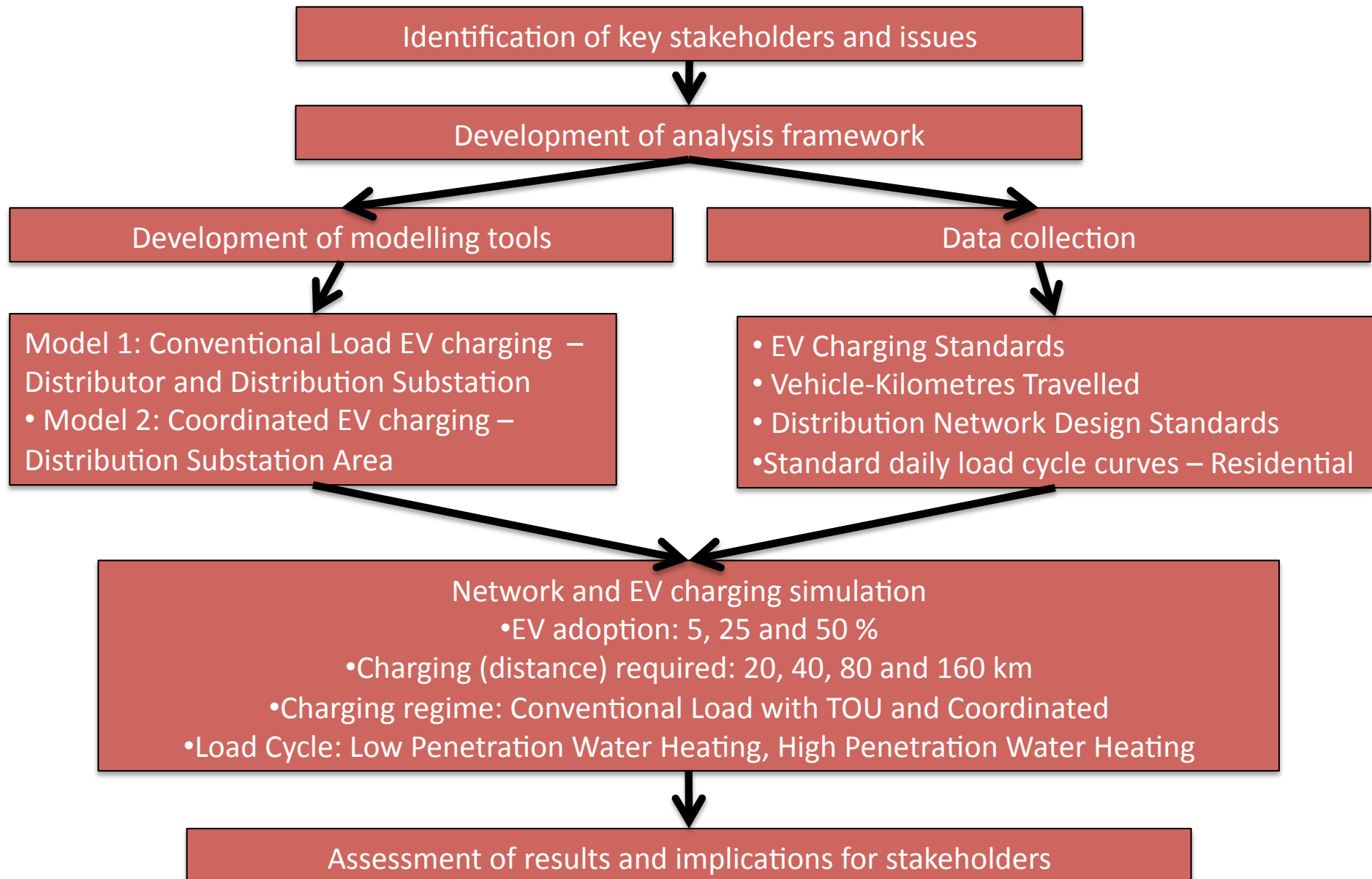
- Why electric vehicles?
- Method
- Simulation Electricity Network
- Simulation Results
 - Single Distributor
 - Distribution Substation
- Conclusions
- Questions

Why electric vehicles?

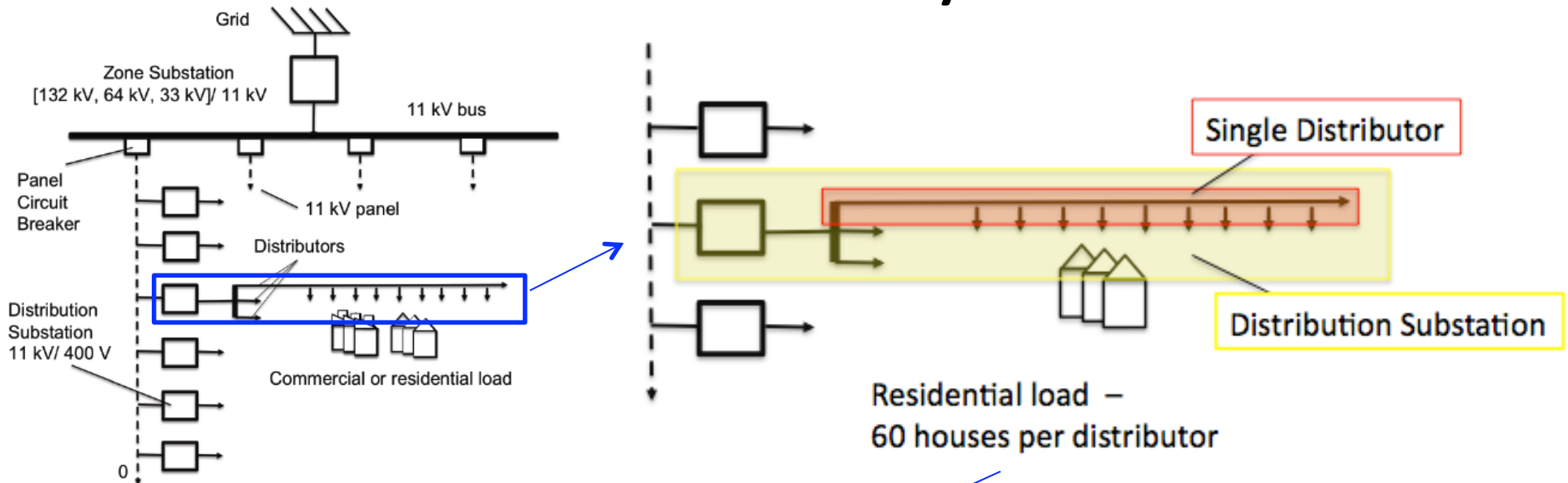


(AER, 2009; National Greenhouse Gas Inventory, 2009; Simpson, 2009, Taylor et al. 2009)

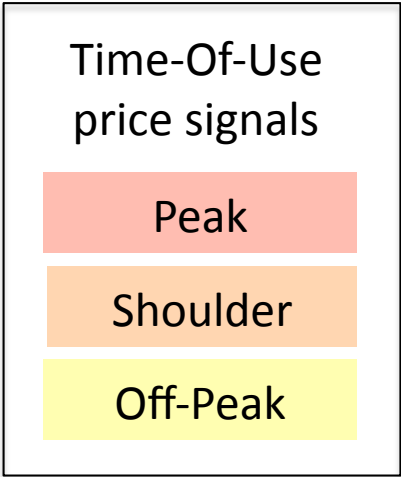
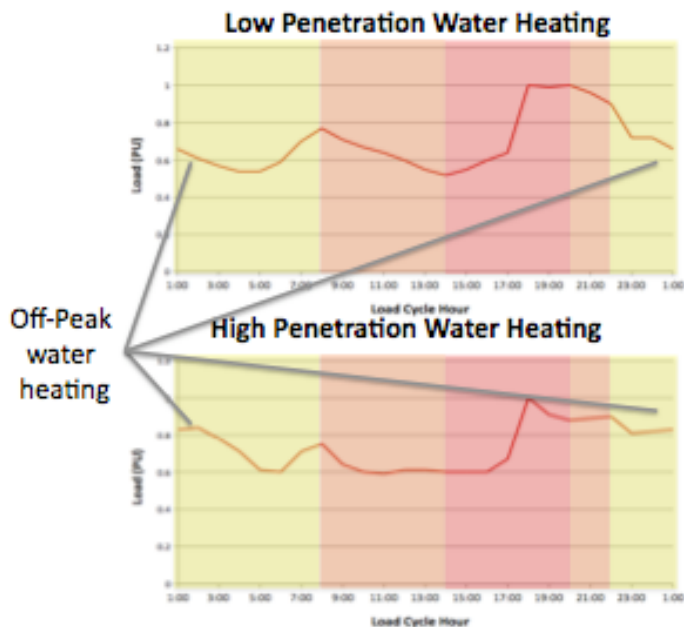
Method



Simulation Electricity Networks



Residential Load Cycles and Time-Of-Use Electricity Pricing

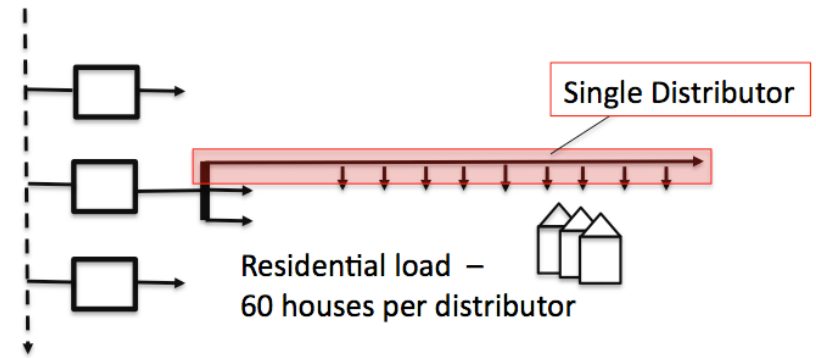


Electric vehicle typically plugged in 6 pm – 8 am



Load cycles courtesy of EnergyAustralia

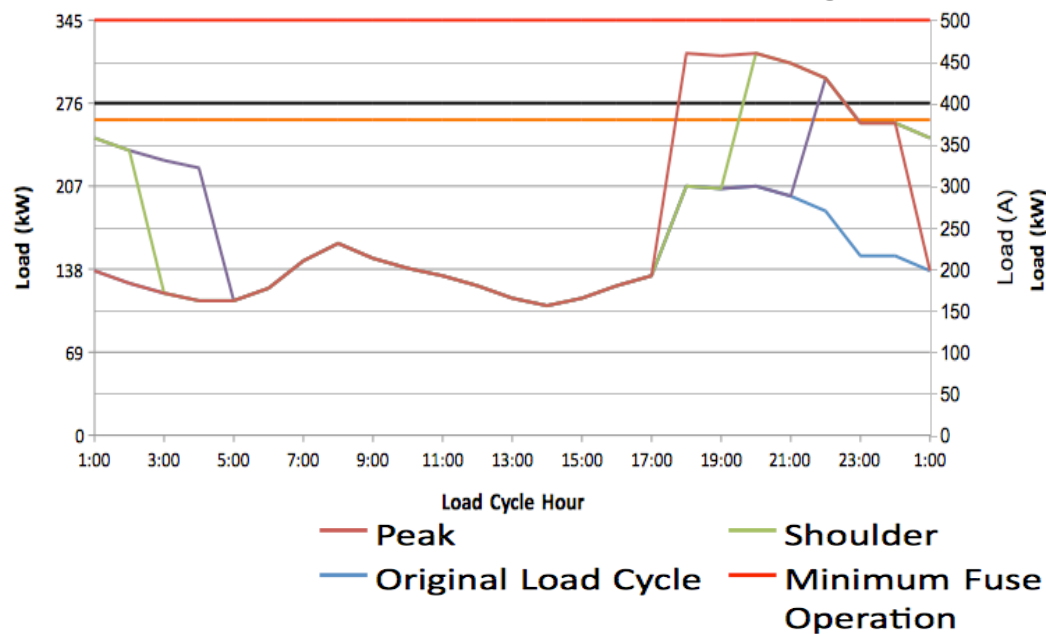
Single Distributor – Conventional Load Charging



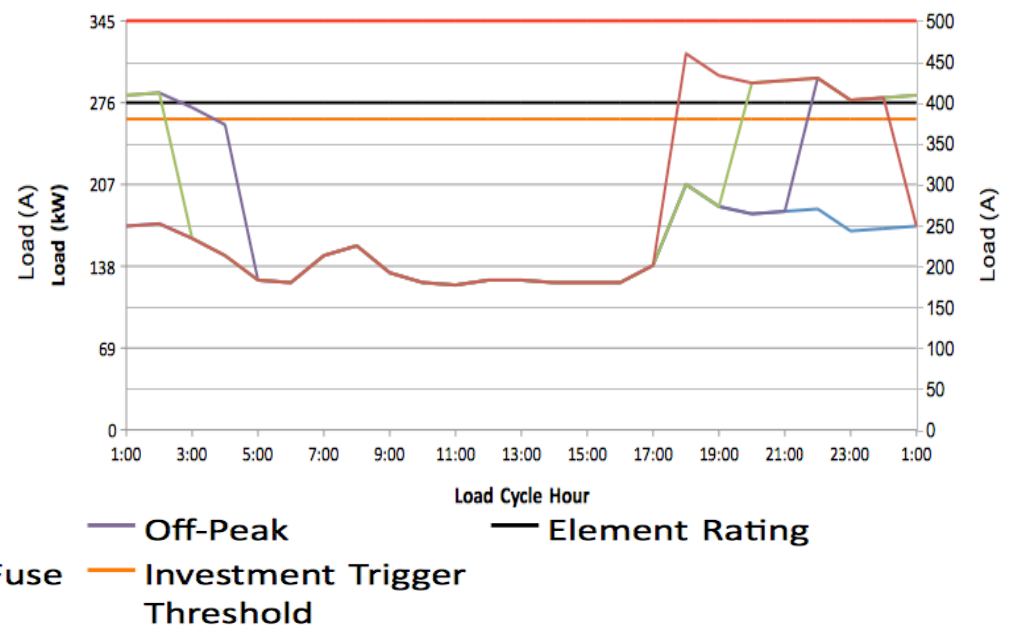
Variation	Outcome
EV adoption rate increase	Maximum load increase – Note: max and min load difference
Charge start delayed (TOU)	Maximum load increase generally smaller
Longer charging distance	Distributor operates at increased load for longer

400 A Distributor – 50 % EV Adoption

Low Penetration Water Heating

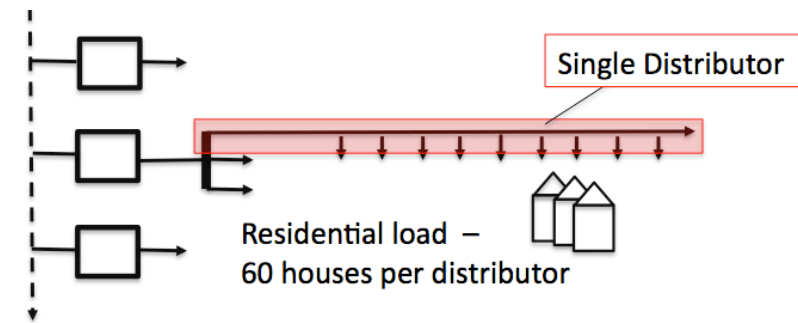


High Penetration Water Heating



- Peak
- Shoulder
- Off-Peak
- Element Rating
- Original Load Cycle
- Minimum Fuse Operation
- Investment Trigger Threshold

Single Distributor – Coordinated Charging



Shorter distance, lower EV adoption

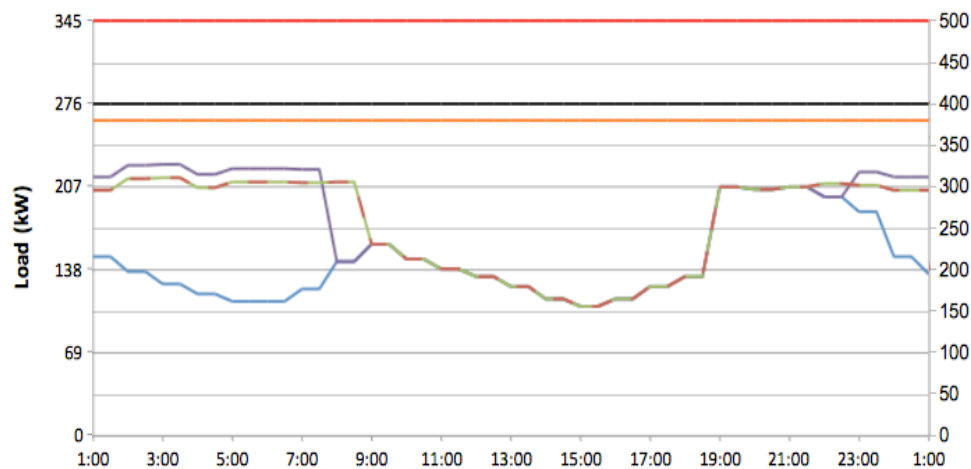
No change to existing maximum load

Worst case (long distance, high EV adoption)

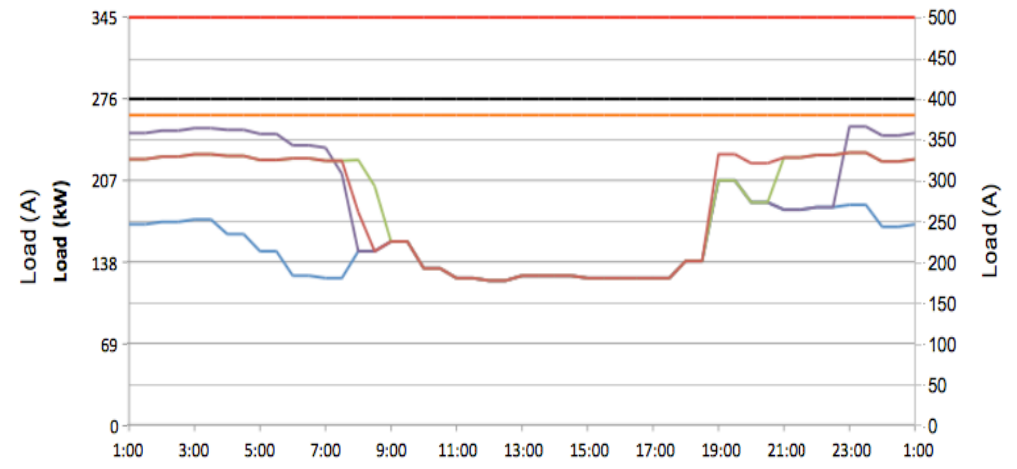
New maximum load for both load cycles, but increase significantly smaller
With delayed start time, higher maximum load – opposite to conventional load charging

400 A Distributor – 50 % EV Adoption

Low Penetration Water Heating

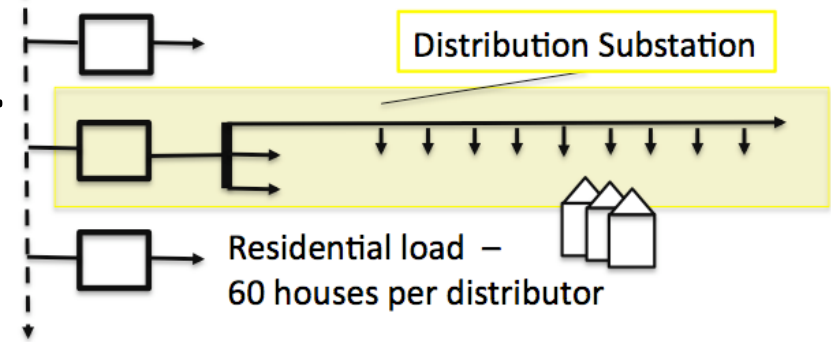


High Penetration Water Heating



- Peak
- Shoulder
- Off-Peak
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Distribution Substation Coordinated Charging



Load Cycle	Charging Regime	Charging sufficient for expected daily travel* without changing maximum load?	Full charge possible below network investment trigger?
Low Penetration Water Heating	Peak	✓	✓
	Shoulder	✓	✓
	Off-Peak	✓	✗
High Penetration Water Heating	Peak	✓	✓
	Shoulder	✓	✓
	Off-Peak	✓	✗

Decreasing

Sufficient Off-Peak capacity?
 How does this affect network planning assumptions?
 Electric vehicle owners?

*Expected daily travel for Sydney 18 km (NSW Transport Data Centre, 2010)

Conclusion

- Broad range of benefits are driving interest in electric vehicle deployment
- Widespread adoption of electric vehicles will depend on successful integration into the existing electricity network
- Growth of maximum load seen to increase with adoption rate
 - At low EV adoption rates, almost no load increase
 - Impacts vary for different load cycles
 - Impacts depend on network level
- Management with price signals and charging coordination (latter more effective) could be an effective way of preventing network expansion requirement
- Change in network operating conditions will need to be considered in network planning

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Thank you and questions?

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