EXECUTIVE INSIGHTS

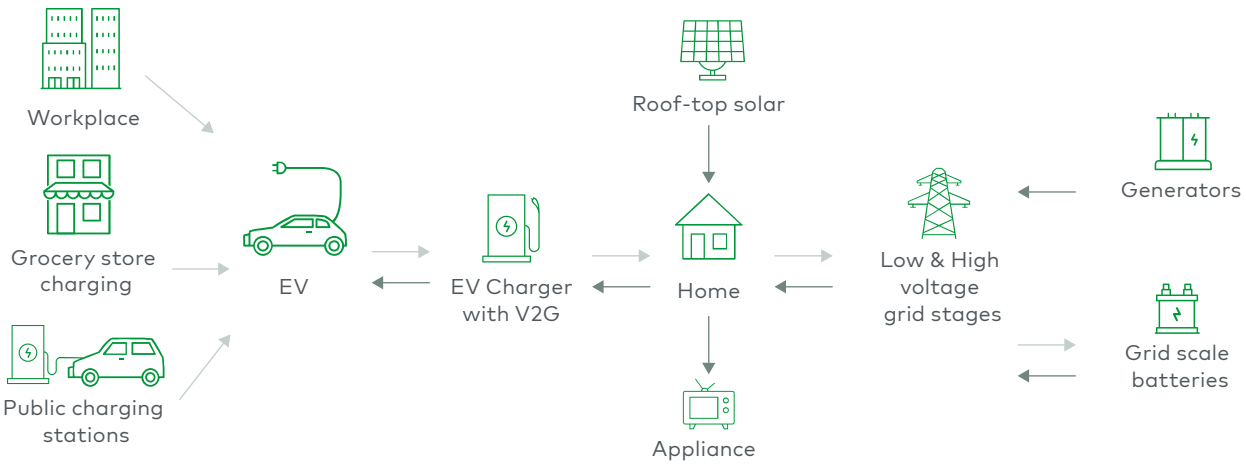
Are EVs the solution to our energy market woes?

Adoption of electric vehicles (EVs) is accelerating in Australia, the result of new models, high petrol prices, improved charging infrastructure and falling costs. New technology that allows consumers to use their EV batteries to power appliances, their homes or the grid has the potential to disrupt the energy status quo in Australia, with implications across the value chain.

V2X 101

V2 'X' refers to charging technologies that enable the transfer of energy from an EV to an appliance, home / business or the grid (see Figure 1). The reason V2X is so potentially disruptive is that it gives EV owners access to a large source of stored energy (in the vehicles's battery) that they can then control. With V2X, the EV can soak up excess

Figure 1
V2X – integration into the energy network



Source: L.E.K. research and analysis

rooftop solar or grid energy and discharge it when prices are high, powering homes during blackouts, or appliances while away from the home (e.g., tools on a building site or a TV at a campground). Integrating power from vehicle batteries into the grid can help reduce demand and price volatility, support higher renewables penetration and reduce the need for dispatchable generation.

V to what?

"V2X" is a broad term that stands for "vehicle to everything." It refers to the communication between the vehicle and another device, such as an appliance or a home. In this context we will focus on the flow of energy from the vehicle to the entity. There are three main variants:

- V2L – "Vehicle to load" refers to using an EV battery to power an appliance – essentially a power point on your EV. This technology is based on fundamentals that differ from those of V2H and V2G.
- V2H – "Vehicle to home" refers to using an EV battery to supply a home via a connection to the switchboard, turning EVs into an alternative source of power
- V2G – "Vehicle to grid" refers to EVs exporting energy from their battery to the grid

The term V2X is also used to describe the communications protocols and standards.

Charting the V2X trajectory

V2X in Australia is still in its infancy, but adoption is expected to pick up very quickly. Only three mass market vehicles fully support V2X today (2019 Nissan Leaf, 2022 Mitsubishi Eclipse Cross and 2022 Mitsubishi Outlander Plug in Hybrid), and there is only one bidirectional charger (a charger that can support energy flow to and from the vehicle) certified for the Australian market. The Hyundai Ioniq 5 and the KIA EV6 both support V2L but are not fully V2G yet.

Adoption of V2X will depend on overcoming a number of barriers. L.E.K. has identified five of these as discussed below.

EV ownership in Australia continues to lag that of other developed countries, however the underlying growth fundamentals are strong. Demand for EVs is now reaching all-time highs, with growth tripling in 2021, 27 new vehicle models launching in 2022[1], and high petrol prices increasing consumer interest. Availability of models remains low, with some selling out within hours or even minutes of hitting the market[2]. The Australian Energy Market Operator (AEMO) expects 1.7m residential EVs by 2030 and 8.3m by 2040 under

the 'step change' central planning scenario. Evidence from other markets (UK, Norway) suggests that adoption may be much faster once supply issues are alleviated.

OEM support. OEMs recognise the potential for V2X to increase the value proposition of EVs, and are actively removing barriers to V2X use. VW has pledged that the vast majority of EVs sold from 2022 onwards will have V2X capability (see Figure 2), with Audi and Mercedes-Benz doing the same. Most remaining EV manufacturers (excluding Tesla) are currently trialling V2X, with larger rollouts likely to occur in the next few years. Whilst no official announcement has been made regarding Tesla, there is speculation[3] that the lack of V2X statements may be due to the technology conflicting with Tesla's Powerwall product.

Figure 2
Status of V2X Support across OEMs

Provider	% of plug-in EV sales worldwide (2021)	Current V2G capability	V2G timeline
Tesla	13.9%	○	Unknown
BYD	8.8%	◔	Recently introduced V2G technology within electric school bus offering
SAIC-GM-Wuling	6.8%	◔	SAIC recently partnered with REV to provider integrated V2G networking solutions, further info yet to be disclosed
Volkswagen	4.7%	●	V2G capability included on every electric vehicle sold from 2022 onwards on the VW MEB platform
BMW	4.1%	◔	As part of a 3-year initiative, BMW has begun testing V2G technology with 50 i3EVs
Mercedes-Benz	3.4%	●	EQS CHAdeMO rolled out in Japan, to be expanded in coming years
Volvo	2.8%	◔	Currently undertaking a V2G trial with partner brand Polestar for the next 2 years
Audi	2.5%	●	As with VW, Audi intends to include V2G capability on every electric car built from 2022 onwards
Hyundai	2.4%	◑	Recently unveiled Ioniq 5 and EV6 which offer "Vehicle to Load" (discharge to power electric devices), in the process of approving V2G alongside an app which allows customer V2G configuration
Nissan	No figures / not in top group	●	Nissan Leaf undergoing V2G trials in Australia
Mitsubishi	No figures / not in top group	●	Expand V2G Outlander capability to other models within coming years

○ No presence ◔ Early-stage testing ◑ Experience with a similar offering ● Approved in road-going vehicles

Source: L.E.K. research and analysis

Charging standards and equipment availability. Plug / cable compatibility with bi-directional charging has been improving, with the most common technologies now supporting two-way charging (CHAdeMO). Standards for combined charging systems (CCS) have also been released. Bi-directional charging equipment providers are also rapidly scaling up, with the Wallbox Quasar recently receiving regulatory approval in Australia.

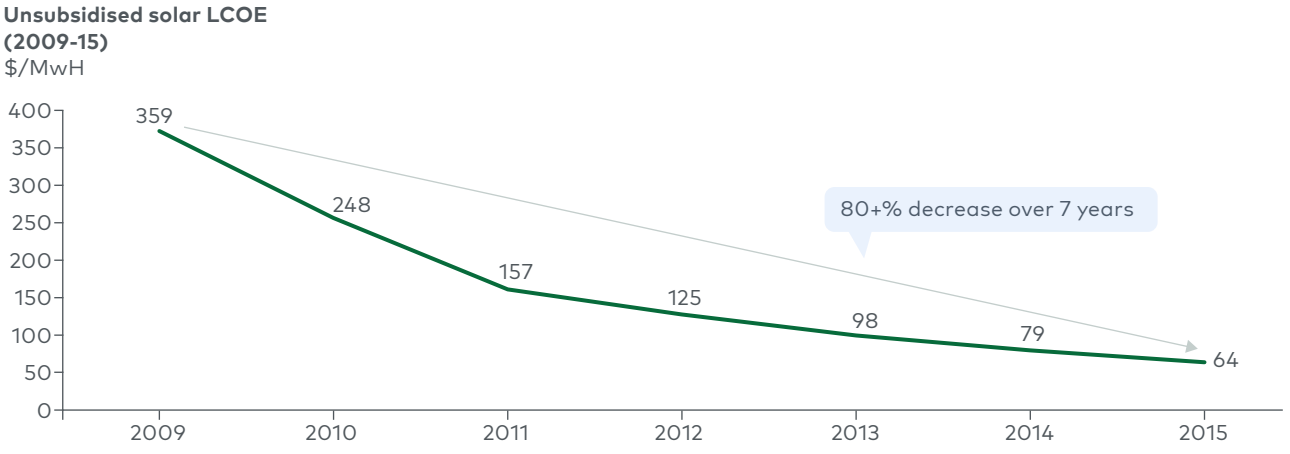
Grid-connection regulation and smart meters. Barriers to residential users supplying the grid with energy are low today (within limits), as evidenced by high solar uptake. Some 30%[4] of households have rooftop solar today, and the rate is much higher in some areas. From a regulatory perspective, exporting from a vehicle via an inverter is no different than solar export. However, congested networks are an increasing challenge, with some distributed network service provider (DNSPs) limiting export rates to c.5 kW, single phase. Many are investing in community batteries and other grid improvements to lift limits.

V2X economics. At $10k[5]+, installing a V2X charger isn't cheap. However, a recent study[6] by JET Charge and The Driven suggests that 70+% of EV owners are interested in V2X. To understand likely uptake rates at different price points, we have modelled a simple payback on V2X ownership for both solar and non-solar users in Victoria. In this example, the household has the EV available at home for most of the day, and the battery is available for use (residential vehicles are typically parked for c.around 95% of any day).

Without V2X, a typical household without solar pays for power at peak prices (28c / kWh) during the 3-9pm period, then off-peak (16c / kWh) prices for the rest of the day. With V2X, this household can shift their demand to all off-peak, by charging their EV battery during the off-peak period and using it to charge their home during peak periods, saving 12c / kWh.

Under this scenario, the payback period for a typical household's c.A$10k+ install cost is lengthy—some 20+ years. However, the technology is nascent, and prices are expected to fall rapidly, similar to what has been observed with solar panels and inverters. For example, in the residential solar market[7], consumer adoption began to accelerate when payback periods dipped below seven years, which would imply a tipping price point of c.A$2k for a V2X charger. Based on price declines seen in related technologies (e.g., solar), this could be five to seven years (see Figure 3) after mainstream OEMs enable the technology.

Figure 3[8]
Lazard LCOE, 2009-15



Source: Lazard LCOE, 2009-15

For a solar household, the benefits of V2X are greater. Solar energy generated over the course of a day that exceeds consumption can be stored for use during the evening and night periods (the typical solar system generates more energy than the average household consumes in aggregate). This represents a cost saving, since energy exported to the grid typically only earns the household 7c / kWh, vs 16-28c / kWh for energy consumed from the grid. The seven-year payback would imply a price point of c.A$3k, reducing the expected 'tipping point' by two to three years.

Implications for the market

As the barriers fall, we can expect adoption to ramp up quickly, and the implications for V2X are dramatic. Two potential adoption pathways are outlined below.

V2X and dispatchable storage market. All of these batteries connected to the grid add up to a lot of storage, so how significant could it be for the expected storage needs of the grid? AEMO forecasts dispatchable storage capacity needs to increase to c.4 GW by 2030 and c.12 GW by 2040, as base load generation is replaced by variable renewable energy. Based on typical durations, this equates to c. 7 GWh by 2030 and 22 GWh by 2040.

How much of the storage needs could fleets of V2Xs represent? AEMO forecasts the number of residential EVs will be 1.7m by 2030 and 8.3m by 2040. Assume each has a 60kWh battery (similar to an entry-level Tesla 3), of which c.30kWh is available for V2X services (assuming consumers keep enough 'in the tank' to cover emergencies and the typical distance travelled per day). Vehicles are normally parked 95% of the day; however, assume, conservatively, that they are 50% available. This fleet represents 25 GWh by 2030 and a whopping 124 GWh by 2040--c.4 times more storage than AEMO has planned in its Step Change scenario in 2030 and c.6 times more than in 2040.

This level of storage on the grid will challenge the role of other grid storage (e.g., grid scale / community batteries). This could impact the viability of community / grid batteries and could set off a race to secure storage as DNSPs look to invest in their regulated asset bases.

Grids on wheels. As charger costs fall, and EVs become more common, workplaces and shopping centres are likely to install charging infrastructure. Evidence from markets overseas (for example, French supermarket Carrefour[9] is installing 5,000 charging points, and the United Kingdom has over 5,000 free charging points, mostly at supermarkets) suggests that these charge points will probably be free, a strategy used by retailers to encourage shoppers to spend more time in-store.

Now consider a household with an EV with V2X. The owner drives to work (as do 65% of workers today), and charges for free; or they do their twice-weekly shop at a supermarket, where they get free charging. Their daily round trip uses 21% of their battery on average. If

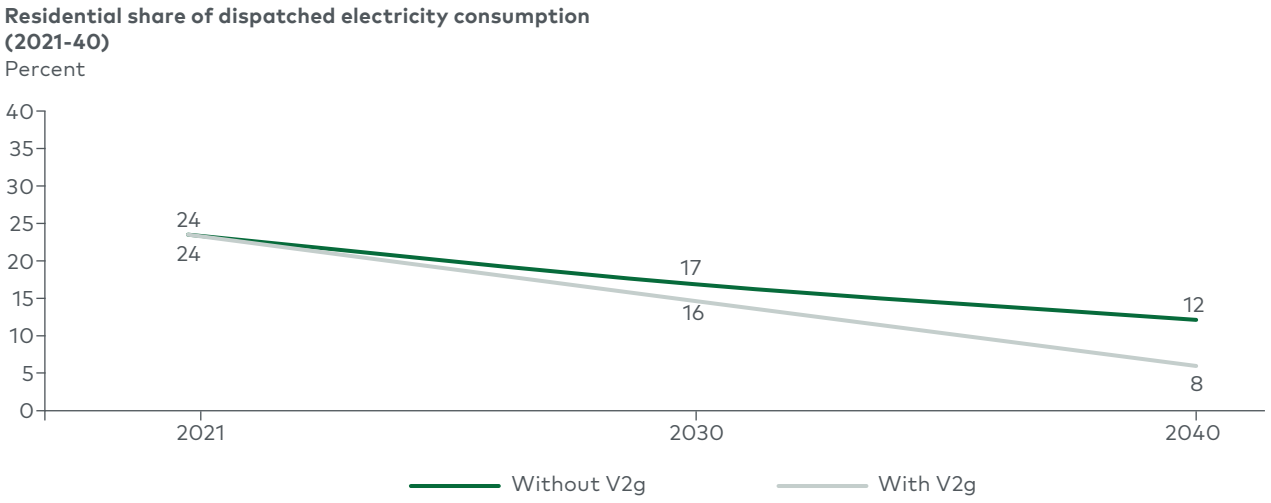
we allow a further 15% for emergencies, that would leave 64% of the battery each day for other uses.

When they return home, they have two options. They can leave their battery full and draw energy from the grid (costing them) or use their battery to power their home – or even discharge some of their 64% into the grid. Most consumers are likely to take the 'free' option, unless they have a particularly long trip planned for the next day.

The impacts of these 'grids on wheels' would be dramatic, representing a large shift in demand from the residential to Commercial and Industrial (C&I) sectors, as consumers fuel up for free. Residential-focussed energy retailers would suffer (since residential load would fall), and C&I retailers would benefit.

Today, households consume 24% of Australia's dispatched electricity. That consumption is expected to fall to 12% by 2040 as rooftop solar continues to increase. Based on the 'grid on wheels' scenario outlined earlier, the uptake of V2X could accelerate that shift, with household share dropping to 8% by 2040. This would drastically impact the model of many retailers and shift requirements for grid infrastructure (see Figure 4).

Figure 4
Proportion of daily residential demand that could be met by V2X



Source: AEMO; L.E.K. research and analysis

DNSPs with assets at work or shopping destinations (for example, CBDs) would benefit from increased load, while those that cover more residential areas would suffer.

Other impacts. The impact of V2X is likely to be felt across other parts of the value chain, including DNSPs, rooftop solar providers, generators, and EV OEMs. High penetration of V2X would negatively impact the nascent home battery market, since most consumers would likely choose V2X (where they can access a 60+ kWh battery) over a typical 10kWh home battery, given it is already part of their vehicle.

EV OEMs, dealers and distributors would benefit, since V2X increases the value proposition and payback period on an EV. V2X supports a lower payback period on solar, handing rooftop solar providers a win. Home and destination charging providers are also likely to benefit.

DNSPs will be impacted in multiple ways. On the plus side they will benefit from rising demand through their networks as EV use increases. However shifting and unpredictable patterns of demand will make management more difficult. DNSPs may need to invest in their networks to support uptake and drive up the regulated asset base. But they may also face questions over equity issues given that the benefits from enabling more V2X would primarily accrue to households that can afford the equipment. DNSP plans to install community batteries may also be disrupted, given the scale of storage entering the grid.

New business models are also likely to emerge; for example, services needed to orchestrate the hundreds of thousands of V2X batteries across the grid efficiently and integrate them into virtual power plant schemes.

Preparing for V2X

The adoption curve for rooftop solar has already shown us what can happen when a new form of renewable energy becomes financially viable for consumers. Industry players should take note. Across the energy landscape, they need to begin planning and preparing for how V2X will impact their businesses. V2X presents both strategic opportunities and challenges, and the rapid pace of change means organisations risk being disrupted if they fail to act now.

Endnotes

[1]https://www.whichcar.com.au/news/2022-new-car-calendar-australia-august-update

[2]https://thedriven.io/2022/08/10/this-is-crazy-hyundai-ioniq-5-sells-out-again-in-less-than-ten-minutes/

[3]https://www.theverge.com/2020/9/23/21451642/tesla-ev-electric-vehicle-energy-grid-battery-day-elon-musk

[4]https://www.energy.gov.au/households/solar-pv-and-batteries

[5]https://www.abc.net.au/news/science/2022-02-14/electric-vehicle-first-ev-chargers-v2g-v2h-to-arrive-australia/100811130#:~:text=Bidirectional%20chargers%20will%20cost%20about,than%20a%20standard%20home%20battery

[6]https://thedriven.io/2022/04/03/most-drivers-want-an-ev-in-the-next-few-years-with-v2l-or-v2g/

[7]https://www.lek.com/sites/default/files/insights/pdf-attachments/1956_Energy_Policy_Economic_Rationalism_LEK_Executive_Insightsv2.pdf

[8]https://www.lazard.com/perspective/levelized-cost-of-energy-levelized-cost-of-storage-and-levelized-cost-of-hydrogen/

[9]https://www.reuters.com/business/sustainable-business/carrefour-plans-ev-charging-stations-french-hypermarkets-supermarkets-2022-03-30/

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