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Lessons Learnt Report – December 2019

Lead organisation: Fast Cities Australia Pty Ltd (trading as Evie Networks)			
Project name: National Ultrafast EV Charging Infrastructure Network			
Project commencement date: May 2019		**Completion date:** May 2022	
Report date:	for the six months ending November 2019		
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Project Status

Evie Networks' National Ultrafast EV Charging Infrastructure Network involves the development and construction of at least 42 ultrafast EV charging sites located along Australian major highways in Queensland, New South Wales, Victoria, Australian Capital Territory, South Australia, Western Australia and Tasmania.

- Spaced approximately 150km apart, these charging stations will support the full range of passenger and light commercial EVs, by supporting both the CCS2 and CHAdeMO connectors prevalent in the market.
- Each site will be built with at least two ultrafast DC chargers, each providing up to 350 kW, though many sites will be future-proofed for up to six chargers, including a high-capacity grid connection to match.
- All sites will be powered by renewable energy.

As of December 2019, the Evie Networks project is on track to achieve its major ARENA milestones as planned:

- The first charging site was launched at Coochin Creek QLD in November 2019. This flagship site is conveniently located at a service center on the Bruce Highway halfway between Brisbane and Noosa. The site includes several notable technical features, such as a shade canopy with integrated solar PV, and a high-capacity connection directly to the Energex 11kV distribution network via a custom-built isolation transformer. The site is designed for up to six 350kW chargers in anticipation of high traffic volumes.
- Development of the broader network is progressing well, with many host leases/licences and power connection agreements now in hand. The next tranche of sites has begun construction and at least a half dozen more sites will go live in early 2020.

Lessons Learnt

Lesson Learnt #1: Complementary Network Planning

Category:	Technical

Evie Networks has purposefully developed an ultrafast highway charging network plan that complements the rollout plans of other ARENA-funded charging network operators:

- To improve the national charging network coverage available for Australian EV motorists, it was recognized early in the planning stages that Evie Networks should develop a mix of sites that both extend the coverage and also reduce inter-spacing relative to other sites in other networks.
- As a result of this, 24 sites are planned around the fringes of the major capital cities in order to improve travel in / out of, as well as across, these congested metropolitan areas. A further 18 sites are planned along interstate highways and major regional routes. All sites are future-proofed with parking capacity and grid-connection tailored to forecast traffic volumes for the site.
- For example, the ~900km Hume Highway from Sydney to Melbourne will include 12 ultrafast DC charging sites (with 8 of these operated by Evie Networks) resulting in site spacings of less than 150km to provide motorists with maximum choice (including for lower-range, affordable EVs).
- This network philosophy "value adds" by enhancing the national network coverage, as well as the total charging capacity, in a way commensurate with the forecast national uptake of EVs.

Figure 1: Evie Networks national rollout plan for 42 ultrafast highway charging sites

Lessons Learnt #2: Ultrafast (350kW) EV charging is a cutting edge but still relatively unproven technology

Category:	Technical / Commercial

Evie Networks understands that the product plans of global EV manufacturers contain an increasing prevalence of 350kW charging cars in the 3-5 year timeline. The first example of this will be the Porsche Taycan arriving in Australia in 2020, with more products slated to follow soon thereafter, particularly from the European and Korean brands. For example, Hyundai and Kia Motor Corporation have most recently invested in the IONITY joint venture and announced that Hyundai and Kia EVs will be equipped with 800V / 350kW charging systems starting from 2021.

Thus Evie Networks is future-proofing its sites by deploying 350kW chargers as standard at all sites.

Figure 2: Evie Networks first ultrafast 350kW EV charging site on the Bruce Highway at Coochin Creek QLD, launched in November 2019

However, there are a number of residual risks associated with the deployment of this cutting edge yet still relatively unproven technology that Evie Networks is still grappling with in the early stages of rollout:

- **Supplier availability** – at the commencement of the project there were only two suppliers of 350kW charging hardware in the Australian market. Evie Networks undertook a rigorous technical and commercial benchmarking exercise to choose its preferred supplier, but neither option was ideally able to fulfill all of our stated technical and commercial requirements.

- **Turnkey solutions** – of the two available suppliers, only one could provide a relatively turnkey solution, but this option was lower-performing and also more expensive. Whereas the other supplier's solution was incomplete requiring additional procurement of customized balance of plant. Evie Networks chose to proceed with the higher-performing, less-expensive option, but was thus also forced to manage in-house the specification and procurement of the additional components, with only limited engineering support provided by the charging equipment supplier.

- **New hardware derivatives and customer support** – both suppliers had only recently launched these products into the global marketplace with first deployments occurring in 2018, and thus only limited field-soak time had occurred to uncover any points of real-world vulnerability in the product(s). Similarly, it takes time for suppliers to build up robust support teams and systems to reliably and promptly maintain their equipment in the field. At the time of writing Evie Networks understands that both suppliers were still working to close-out minor, residual bugs in their initial field deployments. To ensure the long-term success of this emerging market segment, it will be necessary for EV motorists to realise the full promise of a high-performance and high-reliability charging user experience. Evie Networks is still working actively with its supplier(s) to obtain the full desired levels of end-user experience in its first site at Coochin Creek that has just gone live.

Figure 3: Evie Networks first ultrafast 350kW EV charging site on the Bruce Highway at Coochin Creek QLD, launched in November 2019

Lessons Learnt #3: Delivering high-powered grid connections is time-consuming and expensive through inconsistent and unpredictable connection processes

Category:	Technical / Commercial / Regulatory

Ultrafast DC charging sites naturally require a lot of power, albeit for relatively short durations. At the 350kW power level, an individual charging session may take only ~10 minutes (and proportionally longer for cars charging at lower power levels), but for a high-traffic site with multiple chargers operating in parallel the coincident session loads will result in repeated, larger pulses over more sustained periods.

Power supply capacity required for ultrafast EV charging sites

The *diversified peak load* is used to specify the required rating of the power supply to the site, and for Evie Networks' charging sites it typically ranges from a minimum of approximately 400kVA for two charger sites up to a maximum of 1,000kVA (or more) for six charger sites. Limits on the *diversified peak load* are enforced by our site control software, as well as in hardware (circuit breakers), to ensure that the rating of the site power supply is never exceeded. Most importantly, however, it only takes a relatively small number of EVs in the marketplace to create a meaningful probability that coincident charging site loads will rise to these stated limits (even while the overall site utilization remains otherwise low).

Thus it is fundamental to Evie Networks' rollout plan that site power supplies should be future-proofed.

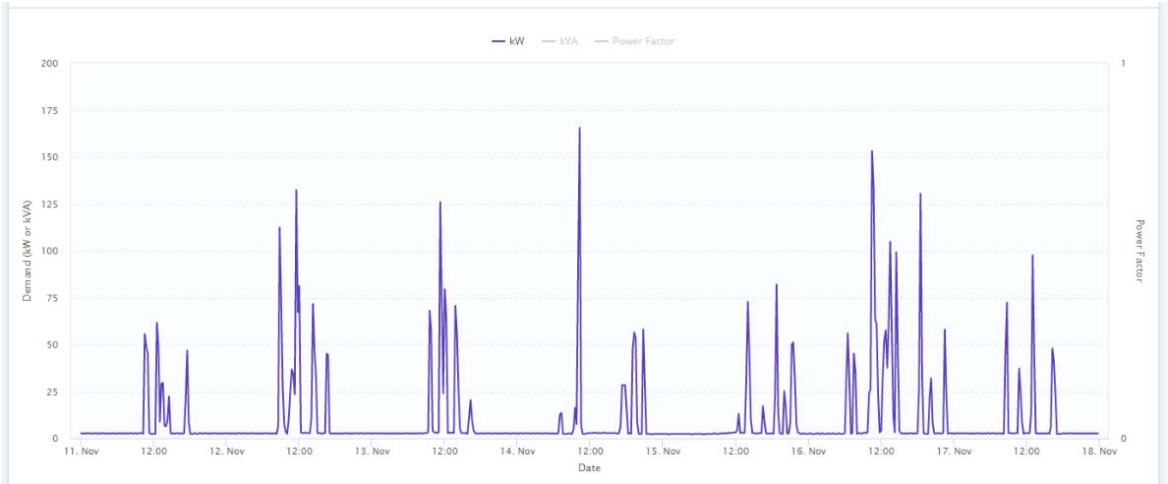

Figure 4: Site loads (15 min intervals) for the first week of operation at Coochin Creek QLD

Charger energy throughput is naturally low in these early stages of the Australian EV market but is forecast to rise substantially over time. For example, Evie Networks predicts that a six charger site rated at 1,000kVA may deliver approximately 1GWh per annum, equivalent to more than 100 houses.

At these power levels, the electricity distribution network is the obvious place from which to seek a future-proofed, high-reliability, high-power electrical supply. It would be impractical to repeatedly upgrade the grid power supply over time given the prohibitively time-consuming and expensive processes involved, thus this is not an option commercially. Alternative solutions (such as batteries) may be considered, but these would normally only supplement grid power anyway, and the value of these systems will erode over time as they wear out and as the site utilization rises to draw more sustained levels from the grid.

Grid connection leads to two fundamental challenges in the planning of our network:

1. **Rollout planning for 42 sites** – as per our stated obligations to our investors and ARENA, we need to deliver future-proofed grid connections on time and on budget, yet we commence the process not even knowing the exact locations for the intended points of connection, thus we also don't yet know the feasibility of connection as this naturally depends on the location.
2. **Business case evaluation** – future-proofing requires a significant upfront capital investment in the grid connection, even though it may take years for site utilization to achieve the forecast levels (based on growing uptake of EVs). Furthermore, the estimated connection costs and forecast site demand growth are both subject to very large uncertainties (and as above, these estimates are site specific depending on the resulting exact locations), thus the inherent risks in evaluating the business case are fundamentally high.

Evie Networks has experienced that the inherent risks in delivering a portfolio of high-powered grid connections are exacerbated by the inconsistent and unpredictable processes adopted by the distribution network service providers (DNSPs). In many cases there has also seemed to be a general *fear of the unknown* in terms of connecting this new ultrafast EV charging technology to distribution networks.

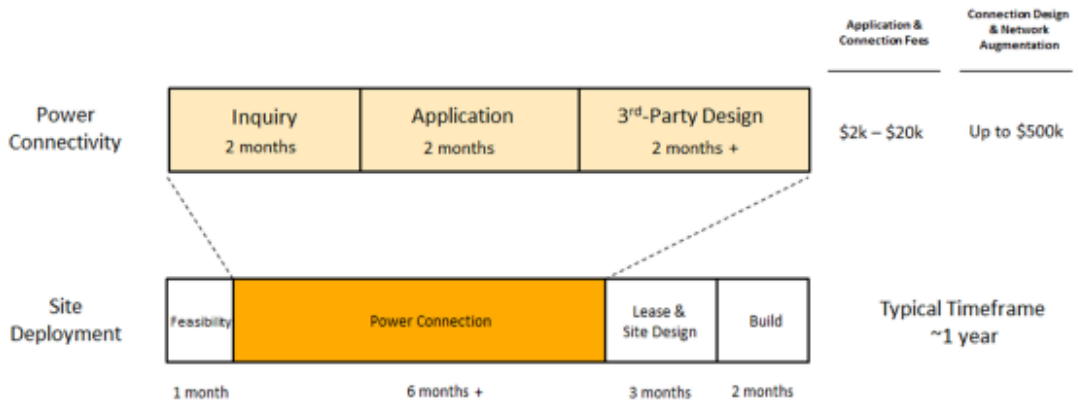

Figure 5: The typical process for new, high-power, grid connections for ultrafast charging sites

Evie Networks will provide a detailed account of its learnings from DNSP engagements in a future knowledge sharing deliverable in line with one of its major ARENA milestones. Below are some anecdotes from the experiences and lessons learned to date.

<u>Scope of Evie Networks' rollout plan overlaid on DNSP service areas</u>

The scope of Evie Networks national rollout includes 13 different DNSPs across 7 States and Territories:

- There are 4 DNSPs encountered in Victoria alone! There are a further 3 in New South Wales and 2 more in Queensland, leaving just one each in Australian Capital Territory, South Australia, Western Australia and Tasmania.
- Across the country, these DNSPs employ at least 3 different distribution voltages, which results in inconsistencies in connection design topologies and the specifications for balance of plant.

Connection process issues

Evie Networks site selection criteria are necessarily designed to deliver a convenient, high-value, end-user charging experience to attract customers and provide a return on our network investment, but unfortunately our requirements often do not align with DNSP planning preferences:

- 1st priority: convenient access to main roads / large traffic volumes for EV customers
- 2nd priority: provision of customer amenities for safety, security, convenience and comfort
- 3rd priority: identifying a willing host landlord and/or commercial retail partner
- 4th priority: future-proofed power supply

Furthermore, Evie Networks commences the site acquisition process by identifying a target search ring within which to locate the site as per the macro network plan, but the precise site location cannot be confirmed with the DNSP and proceed to build and energization unless we simultaneously complete the "*4 Ps*" of property, planning, power and procurement:

- **Property** – negotiating a lease or licence with our site host
- **Power** – negotiating a connection offer with the DNSP consistent with our requirements, which typically also requires us to facilitate a lease/easement with the site host for the DNSP assets in addition to securing our own tenure (see Property above)
- **Planning** – receiving a development approval if/when required by Local Government
- **Procurement** – in addition to our charging equipment and standard balance of plant (for which we can maintain inventory), we often need to procure connection assets such as particular distribution transformer(s) from specific vendor(s) as stipulated by the DNSPs. On several occasions Evie has had to make risk calls to procure DNSP transformers in advance of receiving finalized connection offers in order to adhere to our required project timelines.

There are also marked inconsistencies between various DNSPs in the overall process of designing, negotiating and building the connection. Some DNSPs do the entire process in house, whereas some only do the design in house and require the build to be outsourced, meanwhile others (particularly in New South Wales) require the entire process to be outsourced through a very protracted and expensive process of design, negotiation and construction via accredited service providers (ASPs).

Figure 6: Commissioning a new high-power connection at Coochin Creek QLD: the new DNSP switching station (left) and new metering cabinet (right).

Capital costs of new connections

Estimating capital requirements is a top investment priority for our business, given that the capital requirements of new high-powered grid connections are significant. Evie Networks typically allows $200,000-$250,000 for each new charging site grid connection as a low-voltage customer, which is approximately one quarter of the total cost of building a site.

However in practice we have encountered massive variance of up to ±100% in our grid connections (some have been double the budget allowance, and some free of charge).

- Some DNSPs fund the new connection completely, intending to recoup the costs through tariffs over time, whereas other DNSPs require the customer to pay the full connection capex cost upfront. A further complication is that some DNSPs provide capex rebates based on forecast cost recovery through network tariffs over time, using their own complex in-house formulas.
- We find that valid estimates of connection capital cost often come very late in the overall process of completing the "*4 Ps*", creating significant risk of derailment as we try to reconcile against the requirements in Property, Planning and Procurement. At least one site has failed in acquisition, forcing a total restart, due to a prohibitive connection cost that was obtained too late to manage.

Promoting best practices with DNSPs

Evie Networks has sought out the more proactive DNSPs to collaborate on more suitable processes and funding models for delivering high-power, grid connections for ultrafast charging sites:

- Several DNSPs have offered to "pre-screen" our site candidates in tranches rather than requiring us to pay application fees to wait out the protracted, routine processes for new connections. This helps to de-risk the process by eliminating infeasible site candidates early on.
- Evie Networks has also initiated tariff trial discussions with selected DNSPs, with the full support of the Australian Energy Regulator, in order to design and negotiate connections that are more cost reflective in the overall balance of upfront capex and ongoing networks tariffs.

Evie Networks intends to use our future knowledge sharing deliverables to document these DNSP experiences and showcase our successful collaborations for the benefit of the sector nationally.