

Effective Charging on a Journey

Ian Russell



Introduction

The number of electric vehicles on the road continues to increase, accelerated by the rapid growth in the market share of new EV sales. Most people charge from home where possible most of the time, and those that don't have this facility use local public chargers. While most car journeys tend to be local and infrequent charging is required, there are times when longer trips are made and the use of higher power chargers to enable fast charging during a brief stop is required. In general, *significant* investment has been made in the provision of charging infrastructure to keep pace with the growth in charging demand, and this will need to continue as the transition to electric vehicles continues. In my experience of EV ownership over nearly 15 years, the availability of chargers meets my needs and rarely do I have problems. However, there are times when the demand for charging exceeds the available charger capacity and this can lead to significant frustration. One such time was over the recent Christmas break when a friend had a nightmare journey. This article follows on from a discussion I had with him, explaining some of the charging technology, and sharing some of the best practices I have picked up that can make an EV journey more relaxing. There was enough new for him that I considered it worthwhile sharing further.

Charging on a journey

Any journey starts with a plan. What route are you going to take? How far is it? How many stops do you want to make? Owning an electric car means there is one further question – do I need to charge? While “the best charging strategy is to avoid enroute charging”, if the journey is more than 80% of the range of the car then the answer should be yes (assuming you start off with a full battery).

Suggestion 1: dropping the speed by just 5mph can increase the range dramatically. The energy required to propel a car is proportional to the velocity squared, so this is more significant the faster you drive.

Suggestion 2: Battery capacity and hence range is reduced in cold weather. Range reductions of 20% are typical when the temperatures drop to freezing. Take this into consideration in journey planning and pre-heat the car when still plugged in to save battery energy.

If the route uses the motorway network, then service station chargers can be used, and nearly all services now have a cluster of chargers. However, there are several things to take into consideration:

- a. Time of charging: Chargers are busy around lunch time and early evening, and queues can form for a charger. Plan to charge outside of the busy period.

Suggestion 3: Google maps now shows chargers and the utilisation during the day. Choose a normally less busy period to charge.

Suggestion 4: There are days of the year that the road system operates fully loaded, for example before and after Christmas and on Bank Holidays. Try to avoid these days as the number of chargers is not yet in place to meet this level of demand (if it ever will be).

Suggestion 5: If all the chargers are in use, then make it clear to other people waiting that you are also in the queue. Currently, it is rare to find any formal queuing mechanism, like markings on the ground.

Suggestion 6: Most services have a maximum parking time, typically 2 hours. If you are forced to stay longer than this then you'll need to pay the parking fee. Don't get caught out by the parking company who automatically (using number plate recognition) and aggressively police this and issue fines. If you are fined, they might drop if you can provide evidence that you were queuing for a charge.

- b. Charge Point Operator's (CPO's) typically connect more charging capacity than the grid connection could supply if every charger ran at full power simultaneously, so the available grid power is dynamically shared between all the chargers. This is like a home electrical system: the main fuse is

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sized on the assumption that you won't run every appliance at maximum at the same time. Or like broadband, where the advertised speed assumes not everyone in the neighbourhood is downloading at full speed simultaneously. If too many chargers demand high power at once, the total requested load can exceed the site's grid capacity, and the site will be *grid limited*. The ratio of the sum of the charger's maximum powers to the power available to the site is known as the *Diversity factor* and varies from 1 to 3 or more. Unfortunately, it is rarely published and won't be close to 1! When there is not enough power available to meet the demand, each charger is throttled down with the result that your car may charge at a much lower rate than the expected headline figure, and your charging session takes longer.

Suggestion 7: *If the chargers are fully loaded then move on to the next services.*

Suggestion 8: *If it looks like there are multiple generations of chargers it could be that additional chargers have been added to increase the number of charging slots but not the power available, increasing the diversity factor. Grid power expansions are expensive and take a long time to install.*

Suggestion 9: *If the charger has 2 outlets choose the one where both outlets are free. The power allocated to a charger is normally shared between the outlets and 2 cars will slow the charging down.*

Often, the chargers away from the main trunk roads are less utilised than the services' chargers and tend to have better electricity grid connections.

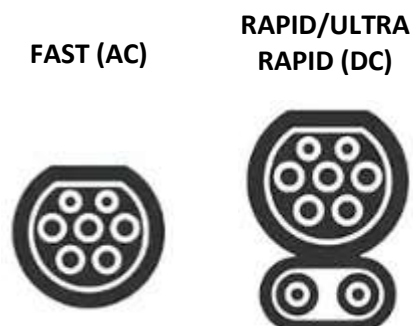
Suggestion 10: *Identify charging hub options off the main route. Note: These might not have the same range of facilities available.*

There are different types of chargers, FAST, RAPID and ULTRA RAPID, and there is quite a lot of confusion around what they are, especially with some CPO's confusing things further with terms like Medium Power and High Power. These terms actually refer to the underlying charger technology, specifically the type of electric current, AC or DC, and the maximum available charging voltages.

- **FAST:** A *Maximum* charging power up to 21KW using a 240V 3-phase AC supply
- **RAPID:** A *Maximum* charging power between 22KW and 50KW using a 500V DC supply
- **ULTRA RAPID:** A *Maximum* charging power between 51KW and 350KW using a 1000V DC supply

Note the use of the term *maximum* as it is the car that actually determines the power that the charger delivers, unless the charger is *grid limited* because the grid supply can't satisfy the total demand. It does not mean that the charger will provide power with a *minimum* of 22KW or 51KW. Each charger will reduce the power to the level the car can take, often well below these figures (see the charts below).

All UK/EU EV's, apart from a few early EV's, use a CCS2 connector in one of its 2 forms. The FAST variant carries the signalling lines so the car can talk to the charger, together with the AC power lines. These tend to be used more for *destination chargers*. The RAPID and ULTRA RAPID variant typically found at *charging hubs* has 2 additional pins at the bottom for the higher voltage DC power. Cars are specified with differing maximum charging power they can use, but they can plug into a charger of any power and, subject to payment authorisation, it should charge - the car will tell the charger what power (voltage and current) to provide.



Suggestion 11: *Always use the connector with the 2 bottom connection pins to ensure you are using the faster DC charging. There is normally a second cap over the pins on the car socket that can be removed.*

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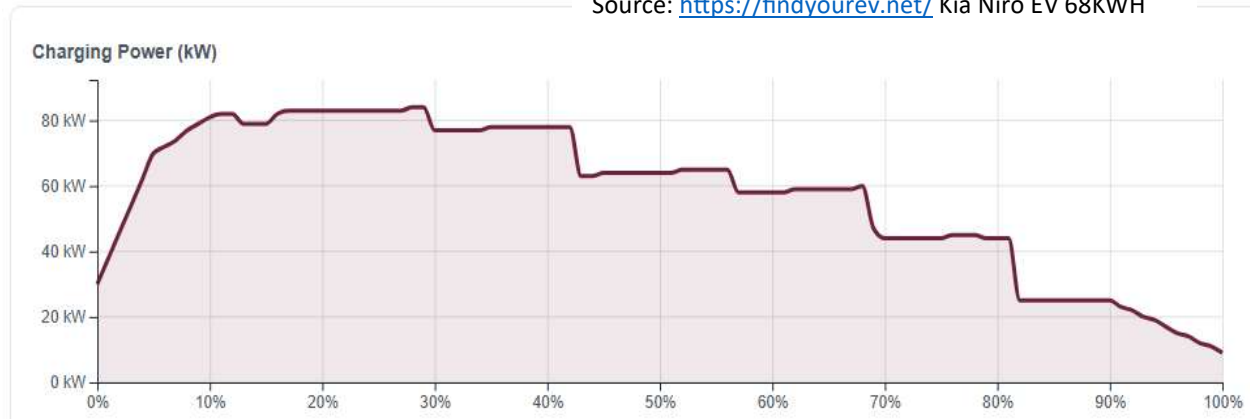
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Suggestion 12: If an ULTRA RAPID charger is more expensive than a RAPID charger and your car wouldn't be able to make use of the higher power, always go for the RAPID.

The car battery management system is optimised, amongst other things, to minimise the charge time and maximise the battery life, two conflicting goals. Because of this the power fed to the battery changes as the battery state of charge increases, as shown in the following *Charging Curve*:

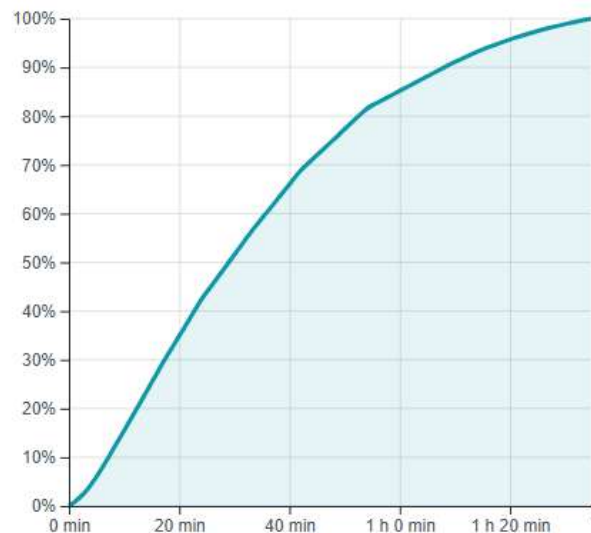
Charging Curve

Source: <https://findyourev.net/> Kia Niro EV 68KWH



And the resulting *State of Charge over Time* curve looks like this. Notice how the charge drops off rapidly as the battery fills. In fact, charging, from 80% to 100% often takes as long as 10% to 80% and one of the reasons that it is recommended that you only charge to 80% on a journey. Of course, you can still go higher if you have the time (and the chargers are not busy).

State of Charge over Time



Suggestion 13: Understand the charging curve for your car by visiting the above website (or similar).

Suggestion 14: It is recommended that your car is set to only charge to 80% when DC charging.

Suggestion 15: Don't get caught out by "idle fees". After charging has finished, disconnect and move away from the charger to free it up for other people to use.

It should be re-iterated that, even if your car is specified as being 100KW capable, this is the *maximum* that it will take and the charging power will often be much lower during the charging cycle.

The other thing to consider is that batteries that have been *pre-conditioned* can start their charge cycles at a higher power and shorten the charging time. This requires the batteries to be warmed for typically about 15 minutes ahead of a charge, which the car only knows about if a charging stop has been scheduled using the car navigation system (some cars have manual activation). While there are other navigation systems, typically on a mobile phone connected to the car using Android Auto or Apple Car Play, these apps can't talk to the car and tell it to start pre-conditioning.

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***Suggestion 16:** Always schedule a charging stop using the car navigation system (even if you are using a mobile phone as well) or use manual activation if available. This will reduce the charge time.*

Pricing per KWH (the unit of energy) also varies by the charger type, location, time of day or might be subject to *dynamic pricing* whereby the price varies depending on how much demand for charging there is. For a variety of reasons, it is more expensive to charge at a public charger compared to home charging. These include (but are not limited to) the higher chargeable energy VAT rate, the cost of the charger infrastructure and grid connections, and rents for the charger bays. By the [Public Charge Point Regulations 2023](#), the pricing has be visible to the user, either on the charger or on a publicly available phone app made available by *open data* shared by the CPO. It is increasingly also being displayed on signage, like fossil fuel prices, as the charging infrastructure matures. All new chargers (above 8KW) must also now accept payment using a contactless card (old chargers and closed networks, like Tesla, don't have to) , and further discounts are often available through the use of the CPO's own app. Whereas once EV owners had a collection of contactless cards, this has now been replaced with a collection of CPO apps!

***Suggestion 17:** Just install the apps for the big nationwide CPO's, or one of the growing network cards, like Electroverse, Zap-map, or the one that your car manufacturer has set up, like Kia Charge.*

***Suggestion 18:** The Tesla Supercharger network is the most advanced charger network in the UK and many of them are now open to public charging through their app. Their price is also the most competitive. It's worth seeking them out.*

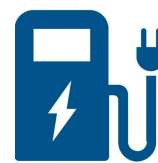
These apps also show the number of chargers, the number in use at that moment and *maximum charging power* for each site, and are worth consulting when planning a journey.

***Suggestion 19:** Google maps and Zap-map show pretty much ALL the chargers (whereas CPO apps tend to only show the ones that are part of their network). For google maps, turn on the "Charging services" category at the top of the map.*

Finding the chargers can sometimes be a problem and currently there is no standardised signage *to the* chargers. It is often left to the CPO to provide, often inconsistently, but a UK government consultation is currently underway to remedy this. However, there is a symbol for chargers in the UK defined in the **Traffic Signs Regulations and General Directions (TSRGD)**, and similarly in Europe (although a variety of symbols can still be found). These are variously used alongside the CPO's branding.



UK



Europe

Chargers, like most things today, can be reviewed and it is worth reading any *recent* reviews. CPO's do read the reviews and try to fix any issues, especially as they are now measured on their charger reliability as per the Charge Point Regulations act.

***Suggestion 20:** Read the charger reviews and consider leaving your own review after charging (even if it is a positive review as these don't often get left leading to an unbalanced view).*

Finally, in your charging plan, make sure you start the journey with a full or close to full battery, and plan to take advantage of lower power (often cheaper) *Destination chargers* when the car is parked up at the end of the journey. These are often found in streets (on-street *charging bays* or *lamp post* chargers), at hotels and B&B's, in car parks, shopping centres and leisure centres – anywhere you are likely to leave your car for a longer period or overnight. Many cars also come with an EVSE (Electric Vehicle Supply Equipment) power supply, more commonly called a *granny charger*, that can be plugged into a 13A socket at a destination, something that is often possible if you are staying with friends. But don't use extension cables as the cables can get hot due to the high charging currents, and don't forget to pay the host for the use of electricity (this is

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probably the cheapest option to the benefit of both parties so you can afford to be generous). Further, a good way to reduce range stress is to charge early when you have plenty of charge left, and only add enough to comfortably get to your destination where you know you'll be able to charge.

Summary

Charging an electric vehicle is part of the ownership experience with a home or local charge quickly becoming second nature for normal use. If the vehicle is used for longer journeys, then the proliferation of chargers across the trunk road network provides a quick and easy option that on most occasions doesn't require much thought – just plug it in when you stop for a break. However, it is worth anticipating and planning for potential problems during busy periods. The charging infrastructure today is not perfect but is rapidly expanding and continues to get better, funded by both public and private investment. I do encourage both the sharing of best practices and providing feedback to the CPOs to help them make their services better. It is hoped that this article has provided some suggestions that help to make your charging experience a positive one. It's also worth reminding ourselves why there is a transition to electric vehicles. Not only are they better vehicles (in my opinion) but they more importantly play a key part in the decarbonisation of transport to enable us to meet the climate change mitigation goals. Enjoy your EV driving.

Footnote

One of the reasons that EVA Cymru exists is to help explain EV technology, whether it be to prospective buyers, to infrastructure providers or to legislators. We have attended several exhibitions and made numerous pitches to conferences, tourist boards and even to a Senedd committee. Please contact us if you would like any support.