Regenerative Braking for beginners – what, how and why!

drivezero.com.au/charging/charging-guides/regenerative-braking-guide

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A lot of the general public know very little about EV's, and unless you've been near one, you're also unlikely to know much about Regenerative Braking. **And that's a shame, because 'regen' is pretty awesome.**

In this guide we'll get into Regenerative Braking, look at how it works, it's benefits, different implementations and what the future holds.

The super-short version

- Regenerative braking – regen – allows electric or hybrid vehicles to reuse the energy generated by slowing down through battery storage
- Regen typically works by acting as a brake on your car as soon as you lift off the accelerator without needing to touch the brake pedal
- Cars with regen still have a brake – you just use that only when you need harder braking power
- You'll find regen on Tesla's, BMW's i range, and most other hybrids and EVs
  It's awesome as it makes your vehicle more efficient and (in my view) – easier and more fun to drive!

What is Regenerative Braking?

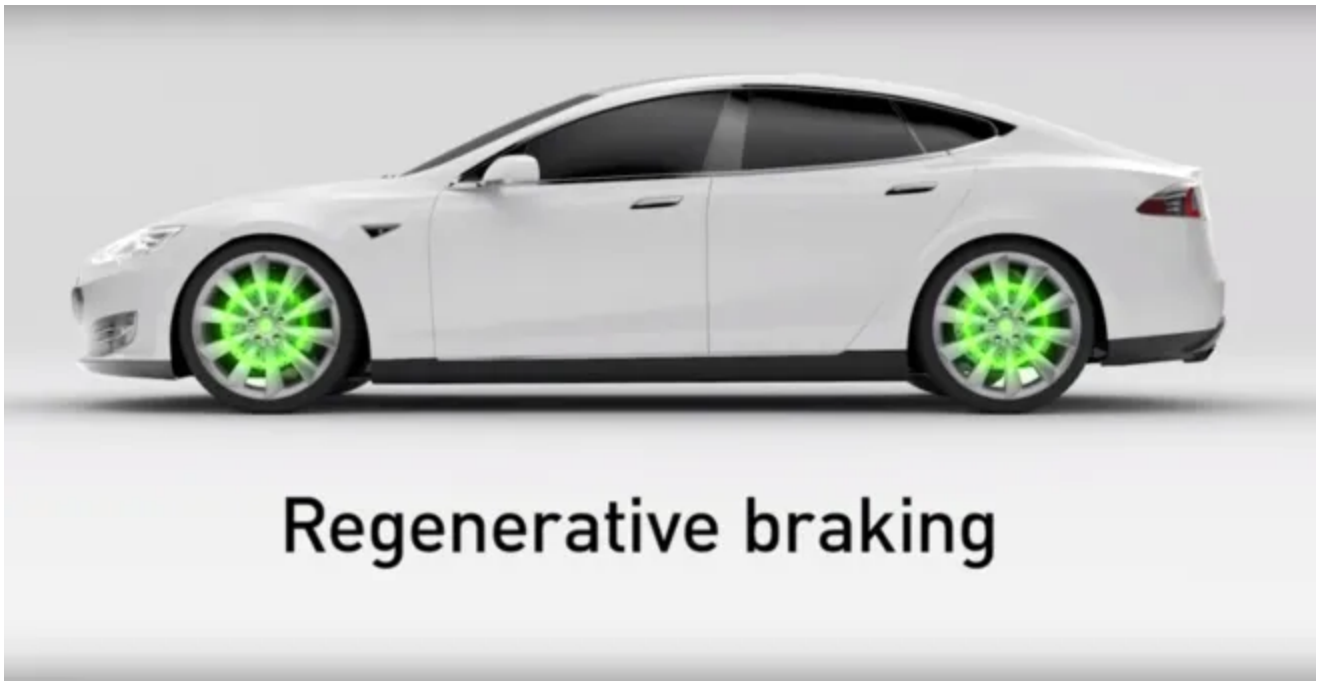
So first up, what ***is*** regenerative braking (also called regen)? Well, for a very technical description it converts the kinetic energy stored in a moving car back into chemical energy that's stored in the electric cars battery.

Probably still not too helpful. Let's try again!

When an electric car is moving it has kinetic energy. This energy is given by the equation $E = \frac{1}{2}mv^2$. So the heavier your car, the more energy it has. The faster it's going, the more energy it has.

As a simple example you can picture two footy players running at each other. The heavier bloke that's running faster has ***more*** kinetic energy and will thus deal a more powerful blow to the other player.

Similarly, a car that's cruising along will have a certain amount of kinetic energy depending on its speed and weight. When you brake on a traditional car, that energy is converted into heat and sound by brake pads, wheels etc. This essentially throws away all that energy and wastes it.



Source: Sonja's SUPER QUICK Tesla Fan Video! – https://youtu.be/4y4rhK-OB5Q

On an ***electric vehicle*** with regenerative braking, the moving car is slowing down the motor turns into a generator and generates power. The wheels and car slow down gradually as the kinetic energy is turned back into electrical energy and then stored in the battery for later use.

This way the EV can operate in ***two separate*** modes. One where the electric motor uses up electricity to push the car forward and a second where it generates electricity from the cars forward momentum.

What are its advantages?

A major benefit is that because you're not using the traditional braking system as much, your brake pads last a lot longer. There are reports of drivers brake pads lasting upwards of 500,000 km's! This means that you have to change your brakes far less often which means lower maintenance costs.

Along with these saved costs it's also adding charge to your battery any time it's active. This means it increases range and you can travel further and regain a lot of what would otherwise be lost energy. So for example if you're driving up a big mountain your battery might take quite a hit. However when driving back ***down*** your battery gets charged back up a bit thanks to all the regen.

What are its disadvantages?

One minor disadvantage is that it's only available on wheels that have motors. So if your EV only has a single motor and is rear wheel drive, the regen will only happen ***on those rear wheels***. Some cars do have AWD because they have two electric motors and so they have regen active on all four wheels.

The amount of regen also falls off as the car slows down. This is because of that equation quoted at the beginning. As the car approaches a stop the regen gets weaker and weaker. You can still bring the car to a complete stop though if you allow enough room.

How much energy do you get back?

Obviously this is going to vary a lot depending on your speed, driving style, car manufacturer etc. It'll also make a huge difference if you're driving on the freeway versus in city traffic. However looking at it from a purely physics point of view we can set a minimum baseline.

When regen occurs, you're effectively using energy to push the car forward, then recovering that energy again. As such, the power must go through the inverter, motor and so on ***twice***. Given all these components aren't 100% efficient you lose some energy on the way through and then again on the way back.

On top of this the car is still losing energy to other things such as the wheels on the road and wind resistance. These also increase as speed increases too. So even if the regen itself was 100% perfect you still wouldn't get all the energy back.

Over the years there have been a number of drivers out there that have done various tests to see what they get. The general consensus is around 20-30% at least for Tesla's. So if you drive 10 km you might see around 2 km of that recovered via regenerative braking which is pretty good.

You're basically getting a free 20-30% boost in range or a 20-30% discount off your driving costs. This is again on top of the money you save by not having to service your brake pads as often.

Which cars have it?

There are quite a few electric cars already on the road that have regenerative braking. Some of the more well know ones both old and new include:

- Toyota Prius
- Tesla Model S or X
- Honda Insight
- BMW i3
- Ford Escape Hybrid
- Chevy Volt

Different manufacturers implement regen in different ways. Some make it very strong, others make it weaker and some also allow you to vary it on the fly. This means that your experience with regenerative braking will vary across different car brands and even different models of the same car.

It's also one of the very immediate and noticeable differences to driving a traditional petrol car. Although if you've always been driving a manual slowing down when you take your foot off the accelerator won't be an entirely new experience!

As more and more EV's get released it will be interesting to see how each manufacturer deals with this new feature. Many different drivers like many different things and it's not uncommon to hear a driver prefer one system over another. Some like them very strong and noticeable. Others would rather them weak or even off completely.

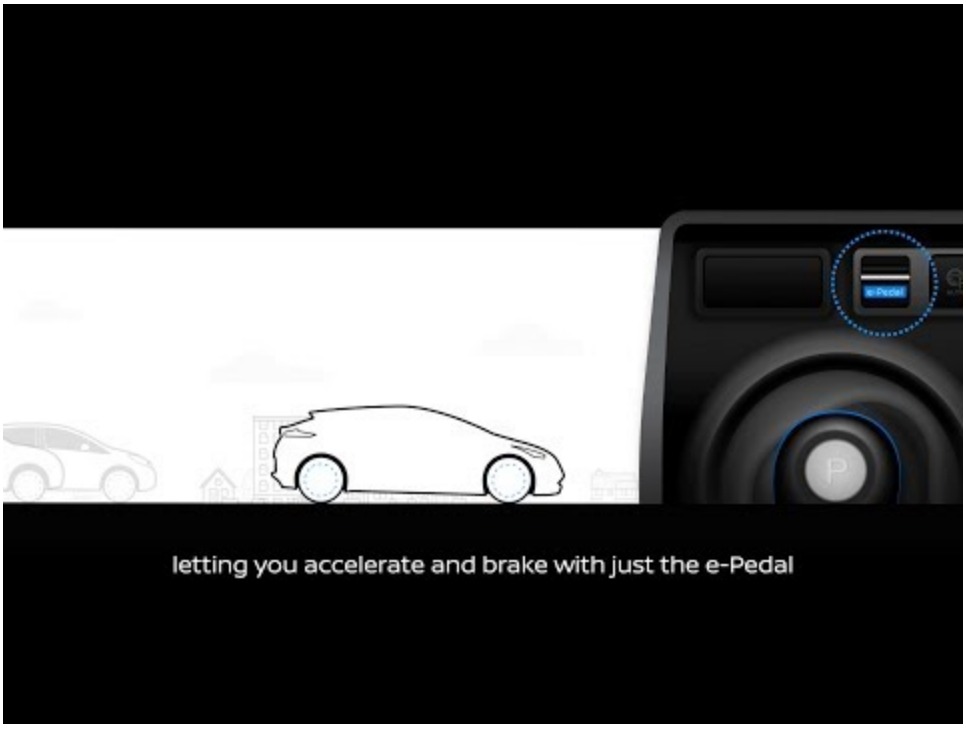
How does one pedal driving work?

Regenerative Braking can actually be quite fun! Many drivers who have EV's with regenerative breaking spend most of their time only driving with one foot on the accelerator. If they want to "brake" they simply take their foot off the accelerator. The regen kicks in and the car slows down.

In the rare case they need to brake a lot quicker they can put their foot on the actual brake pedal and engage the traditional brakes. On top of all this the regen can also serve as a redundant braking system if the traditional brakes ever fail.

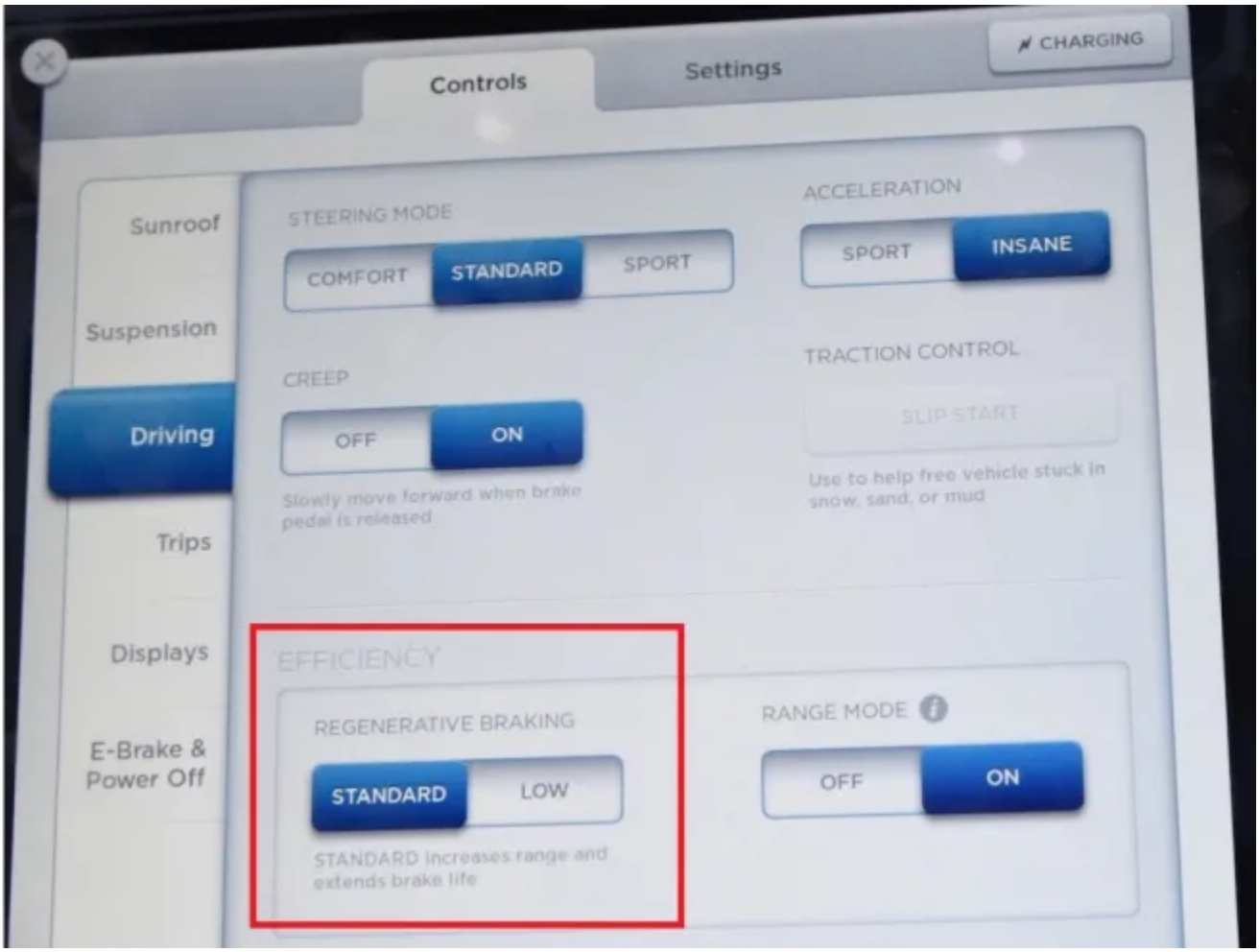
This gives regenerative braking yet more advantages over traditional brakes as it will mean your foot won't get as tired. This is especially the case in city driving where you're stopping and starting every five seconds.

Companies have even started making regen a prominent feature of their new car releases. The soon to be announced Nissan Leaf will have one pedal driving mode which they show off a bit in this promotional video.



Watch Video At: https://youtu.be/V350PLWLCcc

How do the different levels work?



Source: performancedrive.com.au

As regenerative braking is all electronically controlled, you can often vary how strong it is on the fly. Many manufacturers such as Tesla and BMW allow you to dial it up or down depending on your own preference.

In the picture above you can see the menu in Tesla's that allow you to choose Standard or Low. The more aggressive the regen the more energy that is recovered. This increases range and as mentioned, helps to save brake pad wear and tear.

On the BMW they list this under the different driving modes. With them you can turn regen up/down along with many other "eco" modes that the car has such as optimizing the AC system.

> In the sporty COMFORT standard setting, the range of a BMW i3 is already up to 160 km. In the ECO PRO mode, which operates with the adapted accelerator pedal characteristic curve and demands less power, the possible distance travelled increases by up to 20 km.* The ECO PRO+ mode is specifically orientated for range. For this reason, the highest speed of the BMW i3 is reduced to 90 km/h in this mode, and energy consumers such as heating and air conditioning system are switched to an energy-saving mode. Thus, when compared to the COMFORT mode, the possible action radius is increased by up to 40 km – BMW

What about when you're fully charged?

There is one small catch with regenerative braking and that's that it won't work when your EV's battery is full. This is because charging a battery ***beyond*** 100% can do a lot of damage to it. Due to this cars will turn off regen if you've just left a charging point at full.

This is all generally hidden for the driver though, with the car's computer battery management system reducing the amount of regen for when the battery is too full to store more energy. But if you drive down a hill with a full charge expecting full braking to be available, you might get a surprise when it doesn't kick in as hard.

Furthermore, if you're turning a corner and activate regen at the same time it's likely it will either not engage or only do so at a limited amount. This is because the regen effectively puts ***negative*** torque to the wheels (which is why it slows you down).

When a car is turning a corner this negative torque can make the car unstable. As such, the motor control unit will reduce regen temporarily so you don't spin out. Once again though this isn't very noticeable for most people.

The future of braking

While regenerative braking has actually been around since the 1890's, it's pretty easy to see it's the future. Not only does it reduce the maintenance costs of EV's giving them another win over traditional cars it's also fun and safer too.

Looking at the release of some of the newer EV's it seems they are all starting to lean towards giving the driver more choice too. Whether it's various driving modes or just your simple "low/medium/high" settings, hopefully they'll all eventually agree around a logical and simple standard.

Otherwise we could be in for another round of silly sales terms and techno talk that makes everything even more confusing!

So does your EV have regen? Do you prefer it strong or weak? Let us know in the comments below!

First Name

3 Comments

Comments are closed.