blog article

Hybrid, HEV, PHEV - SUV's with CO2 emissions of only 60g/km!

July 23, 2014 Marcel Romijn
Hybrid (/en/blog/?tag=1407542)

Recently Volvo announced a version of the to be released XC90 full-size SUV that would, thanks to Plug-in Hybrid technology achieve a CO2 emissions level of only 60g/km. A good moment therefore to capture the highlights of hybrid technologies in a blog article.

The different flavors of hybrids

To understand first what separates one hybrid from another a short introduction is in order. A Hybrid vehicle is nothing else then a vehicle that has two sources of driving power.

Mechanical/Hydraulic Hybrid

This type captures energy during braking and stores it in either a hydraulic accumulator or in a flywheel type of system. When the vehicle needs to accelerate the energy that was stored is used to support the main power source during the acceleration. Besides Volvo many other manufacturers have been developing Flywheel hybrids. The Hydraulic system can already be found in series vehicles and is often used in trucks, buses and machines that have driving profiles that involve many braking & acceleration events.

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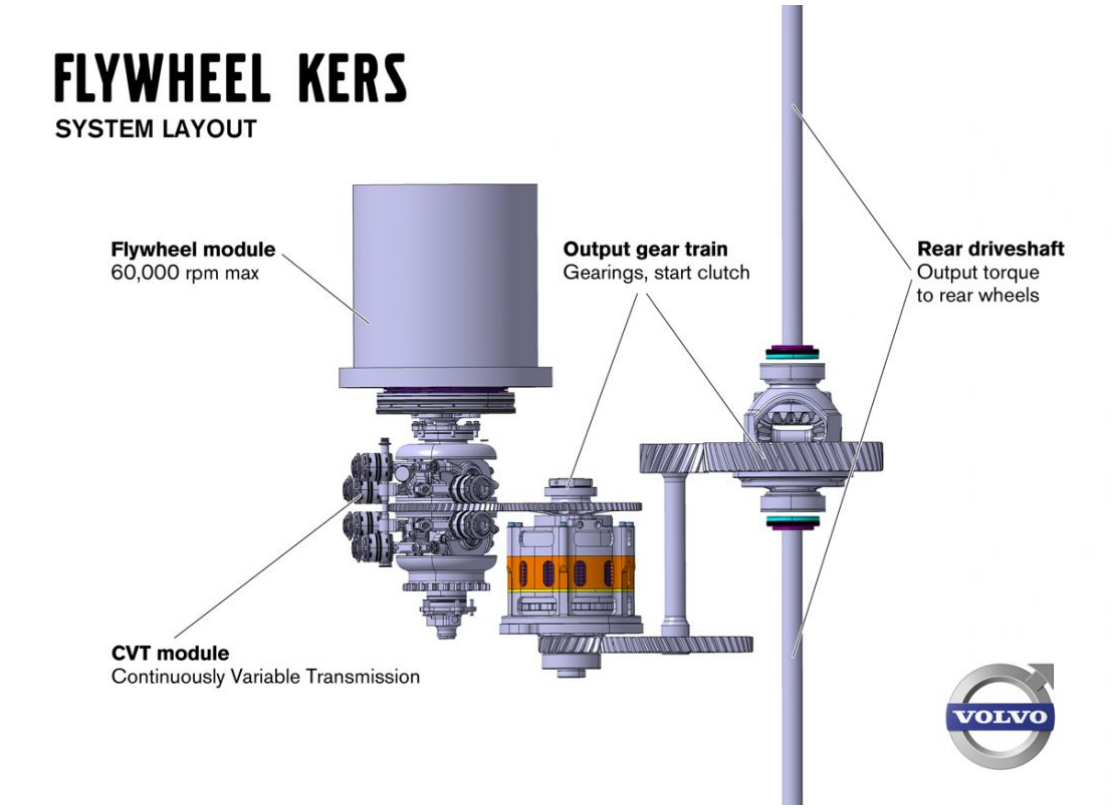

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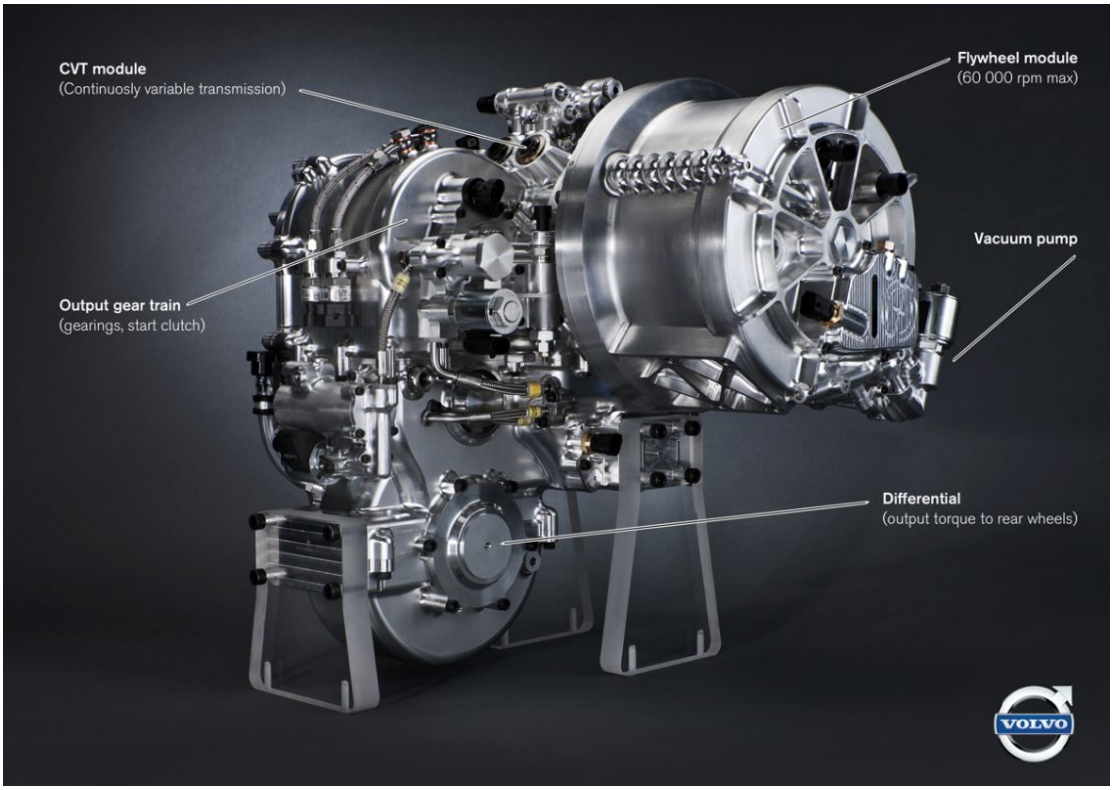
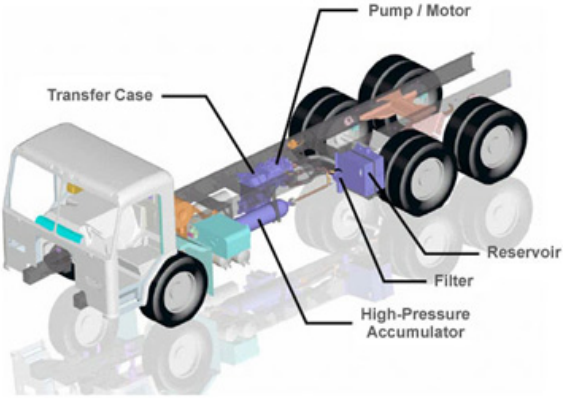
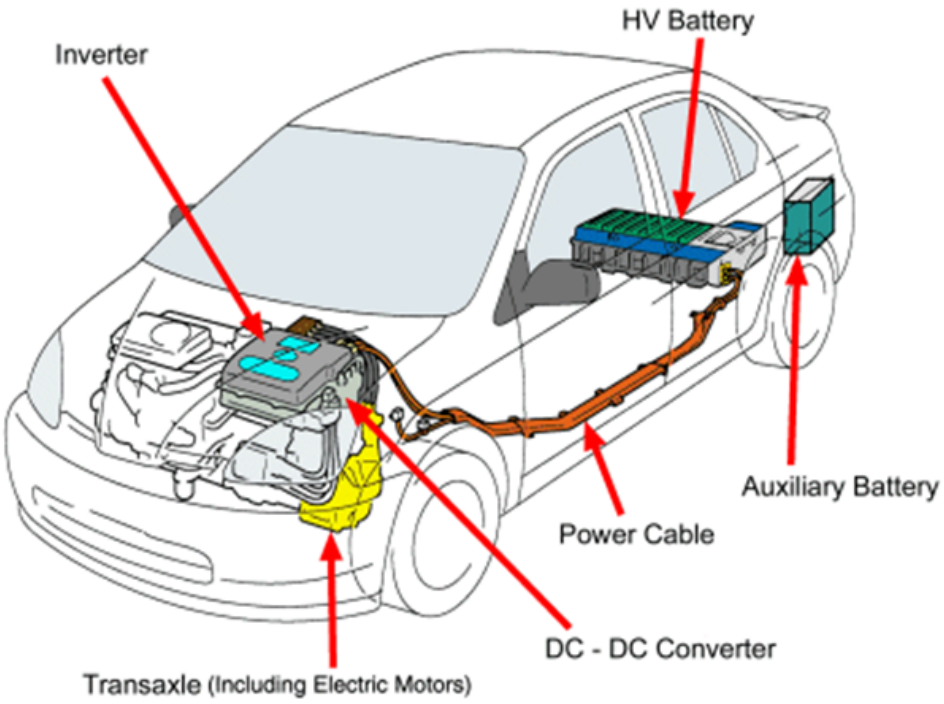




Noteworthy is that Formula 1 and 24heures du Le Mans race cars have had flywheel hybrid systems. Also a special version of the mechanical hybrid, where the energy transitions are in electrics but storage in a flywheel have been used in race cars.

Hybrid Electric Vehicle HEV

This type is the most well known hybrid. Made popular by Toyota's Prius. The energy captured during braking is stored in a battery pack and is later used to support the main power source during acceleration. Also driving purely electric at lower speeds is possible by using the energy that is stored in the battery pack. A large variety of manufacturers use this setup and it's even applied in light trucks.



HEV "light" also exists. Typically in these cars the normal car battery is charged during braking which reduces the load on the alternator for all electrical power consumers while accelerating or steady speed driving. Not often mentioned anymore as it is very common. Also this power can be used to support e.g. an electrical turbocharger such as Formula 1 has in the 2014 season.

Plug-in Hybrid Electric Vehicle PHEV

The Volvo XC90 as discussed. And an already existing Volvo V60 which is the only Diesel PHEV currently. But also applies to other manufacturers such as Mitsubishi with the Outlander PHEV, General Motors with the Chevrolet Volt or Opel Ampera and Toyota with the Prius PHEV. Different compared to the HEV by the fact that the battery pack can be charged from a charging point at home, work or at a car park. Also the battery type chosen allows the battery to drain much more so that more energy can be used for electric driving.

Depending on the ratio of electric driving and combustion engine support also often the phrase range-extender is used. This PHEV are more alike an EV but when the battery is drained before a charging point is found a combustion engine can activate to run an alternator.

Electric vehicles EV

Also found at the charging points are the electric vehicles which have only their battery. Examples are Nissan Leaf, Renault Zoe and all cars made by Tesla. Only one source of power for driving so they are not Hybrids.

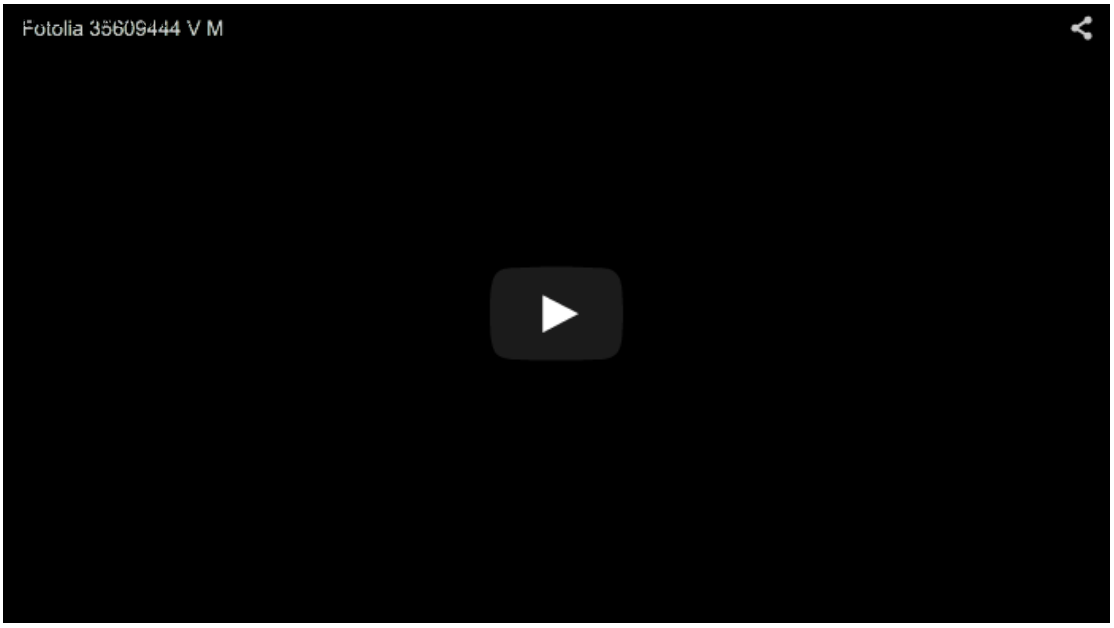
CO2 results

The fuel efficiency of hybrids is linked to the measured CO2 emissions value that the vehicle produces over a specific drive cycle pattern. CO2 is what concerns legislation bodies around the world for impacts to climate change. See also an earlier BRACE blog: https://brace-automotive.com/en/blog/real-life-fuel-economy-versus-manufacturer-specifi/ (https://brace-automotive.com/en/blog/real-life-fuel-economy-versus-manufacturer-specifi/)

When you look at HEV or Mechanical/Hydraulic Hybrids only it is often criticized that large heavy vehicles are converted to HEV to look environmental friendly but still produce tons of CO2. To put it into figures; some large US pick-up trucks may have had a CO2 emissions in the range of 510 g/mile and with a HEV conversion this can be a 400 g/mile. Still considerably higher than many smaller cars that can be in the 100g/mile range. A HEV conversion however of these smaller cars will of course be only percentage wise the same but absolute CO2 emissions will not drop with the same levels. As long as the driving patterns of the pick-up trucks make good use of the HEV system and there are many of them on the road it is actually more efficient to invest in HEV Pick-up trucks to get the CO2 numbers down. Under similar logic now there are also CO2 standards for trucks that will also drive hybridization.

For PHEV the driving pattern and charging behavior is of even more influence. Special adaptations to the CO2 measurement procedures have been and are being developed. Still with PHEV the CO2 can range from practically 0 g/km to similar levels as a non-hybrid car.

So driving patterns are a key parameter. Most HEV and PHEV cars offer Human-Machine-Interfaces that try to coach the driver in making best use of the car to get optimal CO2 levels.



Also the purchase of a car is more and more coupled to what driving patterns the driver would perform often. Already with DPF equipped Diesels it is strongly advised not too drive much short trips with cold engine as it will result in costly repairs. With a PHEV the costs lie in the fuel costs that can remove all fuel efficiency promises when the car is only used for very long highway routes.

An SUV with 60g/km CO2

So to come back to the 60g/km of the XC90. It is incredible that technology makes it possible to have a previous gas-guzzler converted to such a low CO2 level vehicle. The major step from the 200+ g/km results in a significant absolute CO2 reduction. Adding this type of technologies to these large and heavy vehicles really makes a difference. Depending on the driver however better then 60g/km or worse than 200g/km are also possible. When we see these vehicles in use as is often imagined by people how large and expensive SUV's are used (for wealthy families to drive the kids around town) the fuel consumption can be reduced to nearly zero. When these vehicles instead are used for example on long business travels there are no fuel economy benefits of the PHEV system.

So if Volvo can steer their customers in buying the proper version of the XC90 for their use-patterns and their aren't too many market disturbing tax reductions the SUV is no longer the enemy of the green political parties.

An additional benefit comes with the fact that the PHEV will be driving mainly in EV mode in the city. No exhaust gasses that can result in unhealthy smog or particle levels therefore right there where exhaust gasses impact people directly.

What is the use-pattern of your daily driver? And what type of Powertrain would in your opinion match your use-pattern best?

Sidenote:

BRACE has worked on various projects with various types of hybrids:

1) PHEV transmission: https://brace-automotive.com/en/referenties/phev-hybrid-transmission-development/ (https://brace-automotive.com/en/referenties/phev-hybrid-transmission-development/)

2) PHEV lubrication: https://brace-automotive.com/en/referenties/transmission-suitable-for-phev-driving-lubrication/ (https://brace-automotive.com/en/referenties/transmission-suitable-for-phev-driving-lubrication/)

3) Hydraulic hybrid: https://brace-automotive.com/en/referenties/off-highway-hydraulic-hybrid-driveline-1/ (https://brace-automotive.com/en/referenties/off-highway-hydraulic-hybrid-driveline-1/)

4) Flywheel hybrid packaging: https://brace-automotive.com/en/referenties/kers-packaging-study/ (https://brace-automotive.com/en/referenties/kers-packaging-study/)

5) Hybrid gearbox housing: https://brace-automotive.com/en/referenties/gearbox-housing-development-for-hybrid-vehicle/ (https://brace-automotive.com/en/referenties/gearbox-housing-development-for-hybrid-vehicle/)

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Frank Steeghs

I drive a Toyota Hybrid. I live in Eindhoven and my work (ACE Ingenieurs- & Adviesbureau) is also in Eindhoven. For my work I don't travel that much outside this region. I find a hybrid a very good solution for this kind of traveling. It can accelerate fast at low speeds. It has less power on the highway, but more than enough to drive comfortable. I also wouldn't mind to drive an EV, but since we need a family car this hybrid was the best solution.
Funny thing is that I like to try to drive as much as possible in EV-mode. It starts to become a sort of game to drive as efficient as possible without driving as an old lady.

Reply · Like · 2 · July 24 at 2:54am

Marcel Romijn

My wife and I drive Diesels. I drive highway's only with a modern Diesel; so that's a perfect match. She drives rural and city with a SAAB Diesel without DPF, a Diesel with DPF would not survive long.

Reply · Like · July 23 at 8:27am

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BRACE automotive engineers are “passionate about technology”. We develop and engineer automotive systems and components for OEM vehicle manufacturers, 1st and 2nd Tier suppliers and other niche organizations. Our main disciplines are organized in vehicle systems, embedded controls and software, mechanical design and development, and specific competence clusters.

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BRACE presented on OBD architecture at CTI Heavy-Duty Diesel Diagnostics conference 2014 (/en/blog/brace-presented-on-obd-architecture-at-cti-heavy-d/)

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