

The Effects of introducing a Kinetic Energy Recovery System to a Volkswagen Arteon R Shooting Brake

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About the Car



The VW Arteon R Shooting Brake is a performance estate with a turbocharged 1984cc petrol engine producing 320 PS (235kW) mated to a 7-speed DSG dual clutch gearbox which is a tried and test VW performance combination (Volkswagen, 2021). With the heavy focus on emissions and noise restrictions in urban areas this car feels

appropriate and unique to investigate hybridisation whether it will be utilized in the stop start traffic of a busy city or to gain some extra performance on a winding country road. For ease of reading the car will from hence forth be referred to as the “VW Arteon”. In the R trim the VW Arteon gives a sporty alternative to a daily commuter offering greater performance although at the cost of fuel economy. With many performance cars now leaning towards hybridisation such as the likes of the newer Audi RS6 and the new BMW M5 it seems appropriate to consider the potential avenues Volkswagen could explore when it comes to potentially hybridising their trusted and popular two litre 4-cylinder turbo line up starting with their upmarket and more luxurious offering the VW Arteon R Shooting Brake.

Table 1 - Technical Data of the 2021 Arteon R Shooting Brake (Volkswagen, 2021)

Feature	Value
Engine type	Turbocharged petrol engine (TSI)
Capacity / cylinders	1,984 cc / 4
Maximum power	235 (320 PS) at 5,350–6,500 rpm
Maximum torque	420 Nm at 2,000–5,350 rpm
Fuel Tank capacity	66L
Height	1,462 mm
Length	4,866 mm
Width (excluding exterior mirrors)	1,871 mm
Kerb weight	1,793 kg

Dynamic Vehicle Characteristics

Test Mass

The test mass of the VW Arteon is not explicitly stated however the unladen mass for the 2022 model year is reported by Volkswagen to be 1,793 kg (Volkswagen, 2021). The unladen mass of a vehicle is the total mass of a car excluding passengers (and the driver), cargo and fuel where we will need to add 90% of the fuel tank's capacity as well as a driver and luggage which equates to roughly 100kg. The VW Arteon has a fuel capacity of 66 litres which 90% of equates to roughly 59.4 litres. The mass of 59.4 litres of petrol is approximately 42.2 to 46.0 kg its density can vary, especially with temperature. The general density range for petrol is between 0.710 and 0.775 kg per litre (or grams per millilitre) at 15°C. We will take the average of these two values and use the value of 44.1 kg which would give us the test mass of **1,937 kg** when rounded to 4 significant figures.

Frontal Area

The frontal area of the VW Arteon is a lot more difficult due to its complex frontal profile and is not publicly available with the only official figures being with width excluding mirrors being 1,871 mm and the height being 1,459 mm (Volkswagen, 2021).

Unfortunately, due to the complexity of the front profile we are going to have to approximate the frontal area to be **2.22 m²**. This figure is an industry-standard estimate for vehicles in the Arteon's class, often derived from multiplying the car's maximum width by its maximum height and applying a correction factor for the gaps under the car and the non-rectangular shape.

Rolling Resistance Coefficient

Once again there is no official value for rolling resistance for the VW Arteon so we will research and use a very popular tyre for the vehicle which is the Michelin Pilot Sport 4S (PS4S) tyre in a size 245/35 R20 which has a rolling resistance of "c" on the EU tyre label. This value is not specific however third-party tests has calculated an average rolling resistance of the PS4S as 7.8kg/t which is **7.8 N/kN** (Tyre Reviews, 2025). This equates to a rolling resistance coefficient of **0.0078**. This can be deemed as a reasonable value thanks to research done in a 2018 paper stating that the coefficient of rolling resistance for a pneumatic tyre used in motor vehicles on a smooth asphalt or concrete surface is indicated in the range 0.007 to 0.02 with most often indicated around 0.012. Due to the performance nature of the VW Arteon we will keep with the factory available Michelin Pilot Sport 4S tyres.

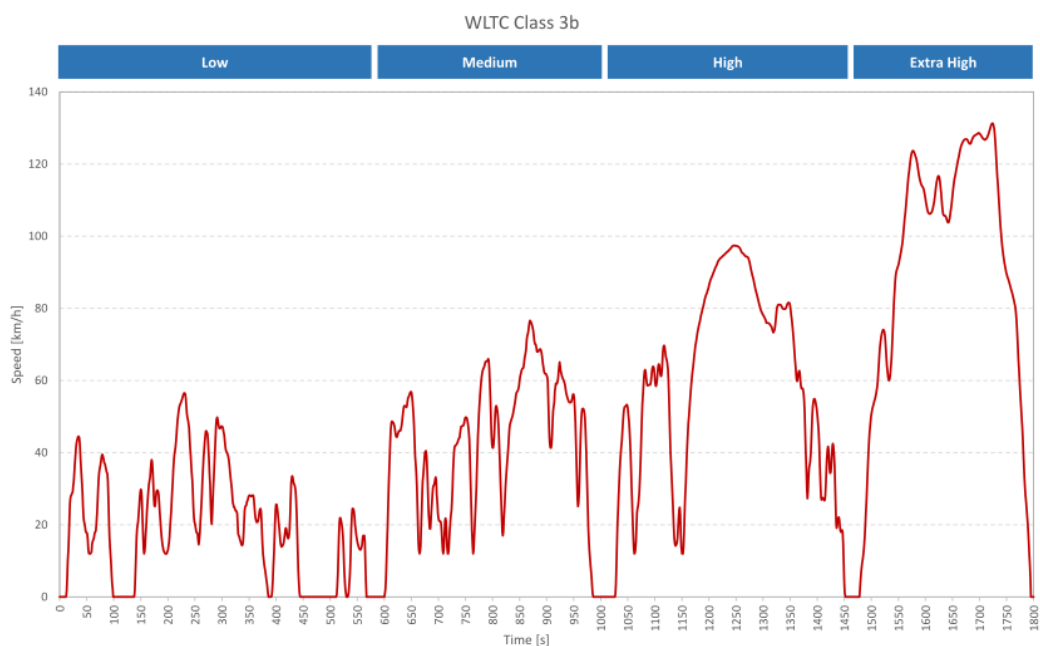
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Coefficient of Drag

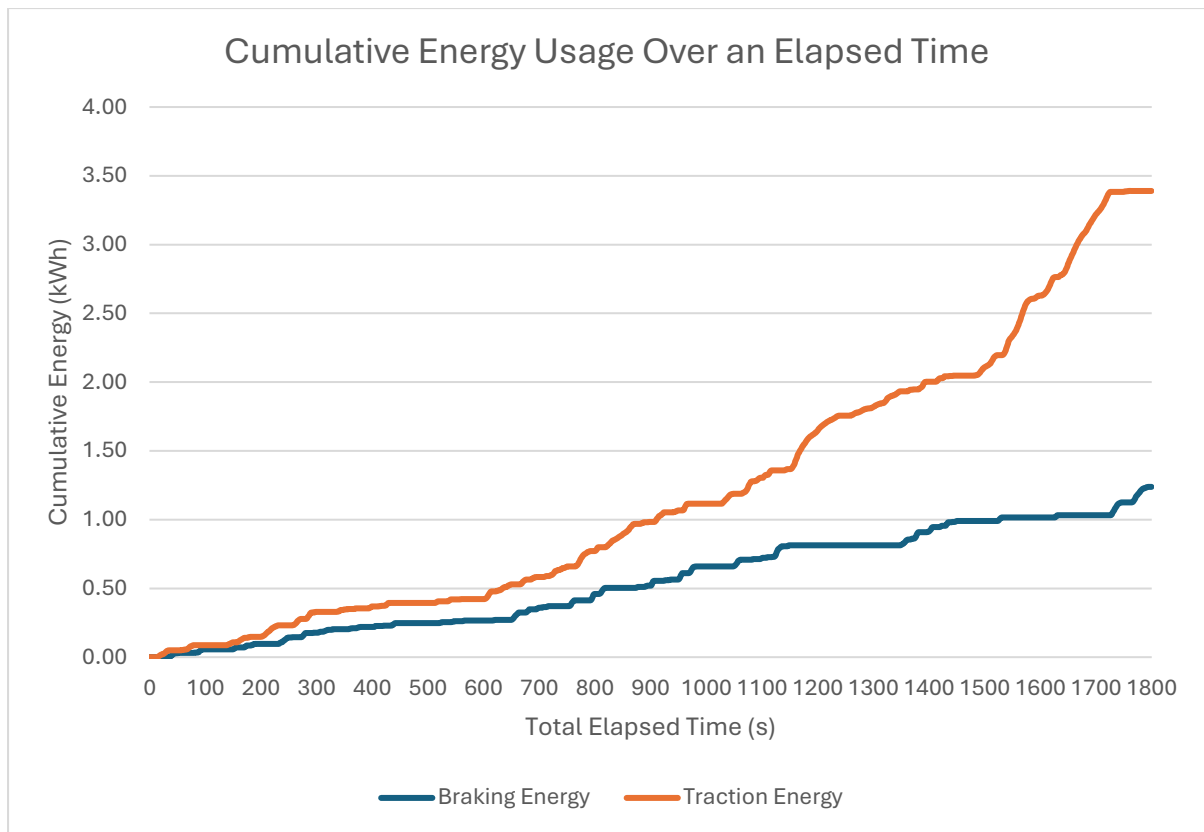
The coefficient of drag is a published value by Volkswagen Press which is 0.265 for all VW Arteon Shooting Brake models (Volkswagen, 2021). This value is very respectable for a car of this type and size thanks to its sloping almost fastback style roof.

3. What Worldwide harmonised Light vehicle Test Procedure (WLTP) will the car adhere to?

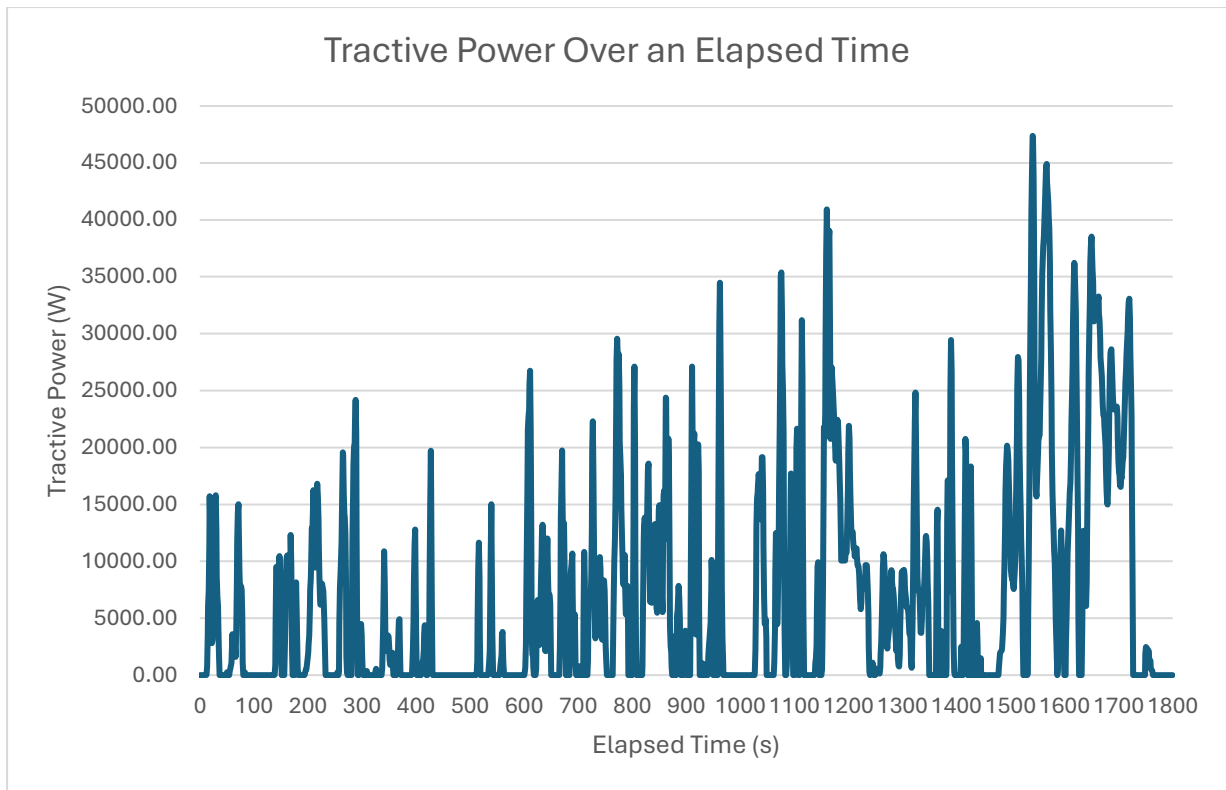
The VW Arteon produces 235 kW of power with a kerb weight of 1,793 kg which would give it a power to weight ratio of roughly **131.06 W/kg**. This value means the VW Arteon will have to adhere the class 3 WLTP pictured below (Volkswagen, 2021).



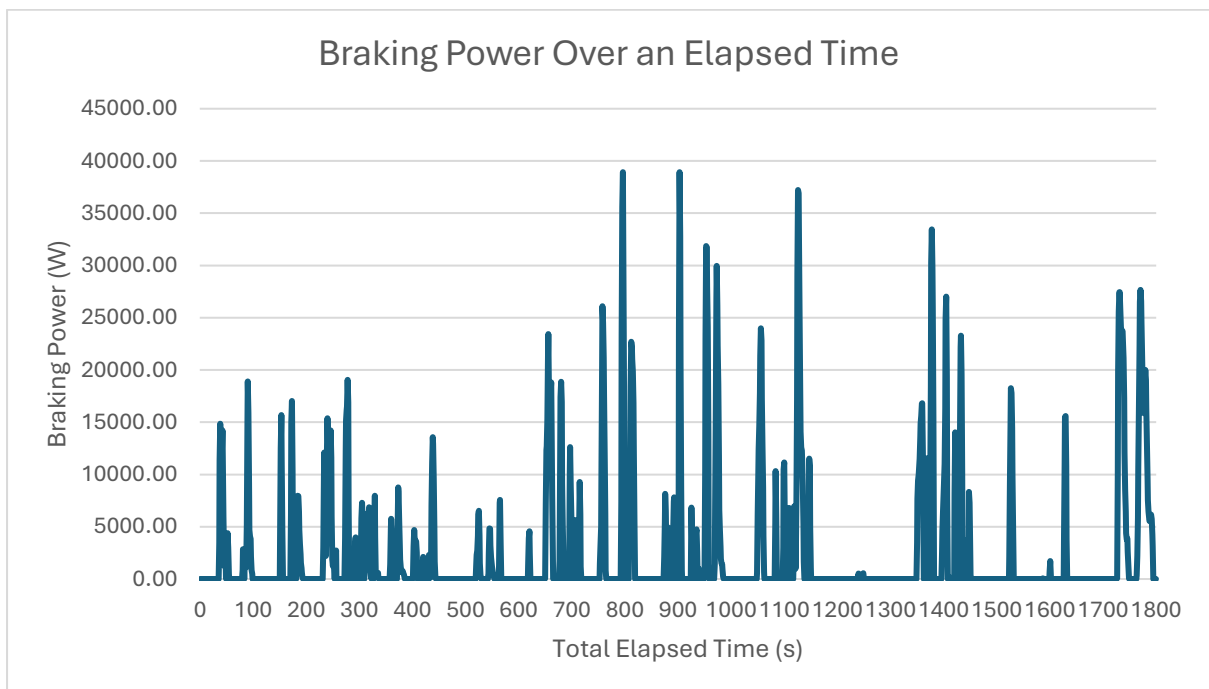
4. WLTP Test Results



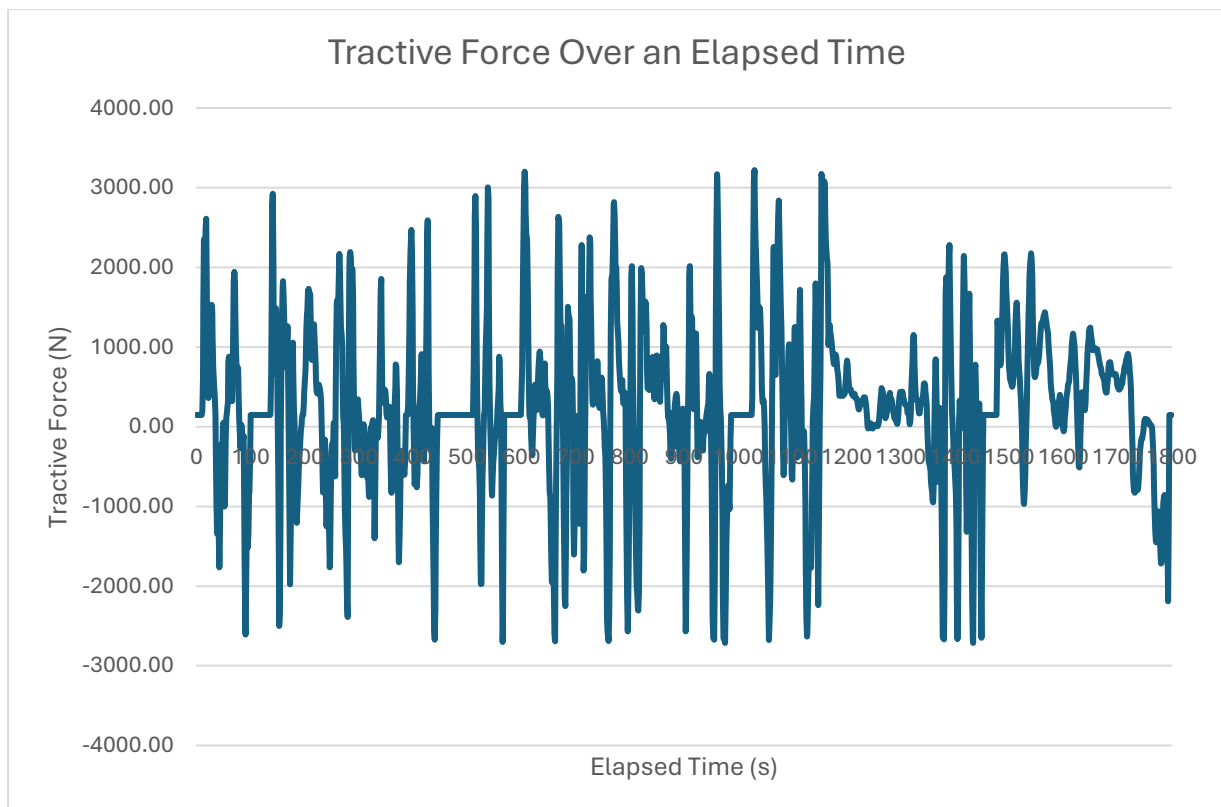
The graph above shows the cumulative energy usage for braking and acceleration (traction) over the course of the WLPT test with the final value of cumulative energy for acceleration 2.47 kWh and for braking 1.52 kWh with a total loss of 0.95 kWh incurred in the cycle.



The tractive power over an elapsed time graph shows when the car is in a state of acceleration.



The graph showing braking power over an elapsed time highlights when the car is in a state of deceleration through either friction brakes, natural resistance or engine braking.



5. Analysing Potential KERS Inputs and Storage

When analysing in closer detail the spreadsheet it is to be found that the Extra-high phase of the WLTP test at the elapsed time of 1731 seconds where the VW Arteon will experience a deceleration of 0.71 m/s^2 and generated a braking energy of 41338 joules (0.11 kWh). The largest moment of energy input is at time elapsed 1541 where the VW Arteon experienced an acceleration of 0.96 m/s^2 and generated traction energy of 436653 joules (0.12 kWh). These high-speed energy recovery areas are ideal in the looking into of a heat energy recovery turbine which uses an electric motor connected to a turbine which uses exhaust gasses to rotate. This recuperated energy during acceleration can be used either to provide a further power boost through an electric motor or to help reduce turbo lag. Considering the target market for the VW Arteon R Shooting Brake which is most likely consisting of middle-class office workers who will likely either commute to work on motorways or even A-roads this would be an ideal way and likely utilised way to recover lost energy. The potential application of reducing turbo lag is also relevant due to the sporty nature of the Arteon with the small capacity turbo engine relying heavily on its turbocharger for its power. This system instead of utilizing energy recovery during braking generates energy during on throttle, this is good as there is more energy used during moments of on throttle than during braking giving the potential of more energy restored during a journey especially one that consists mostly of on throttle sections.

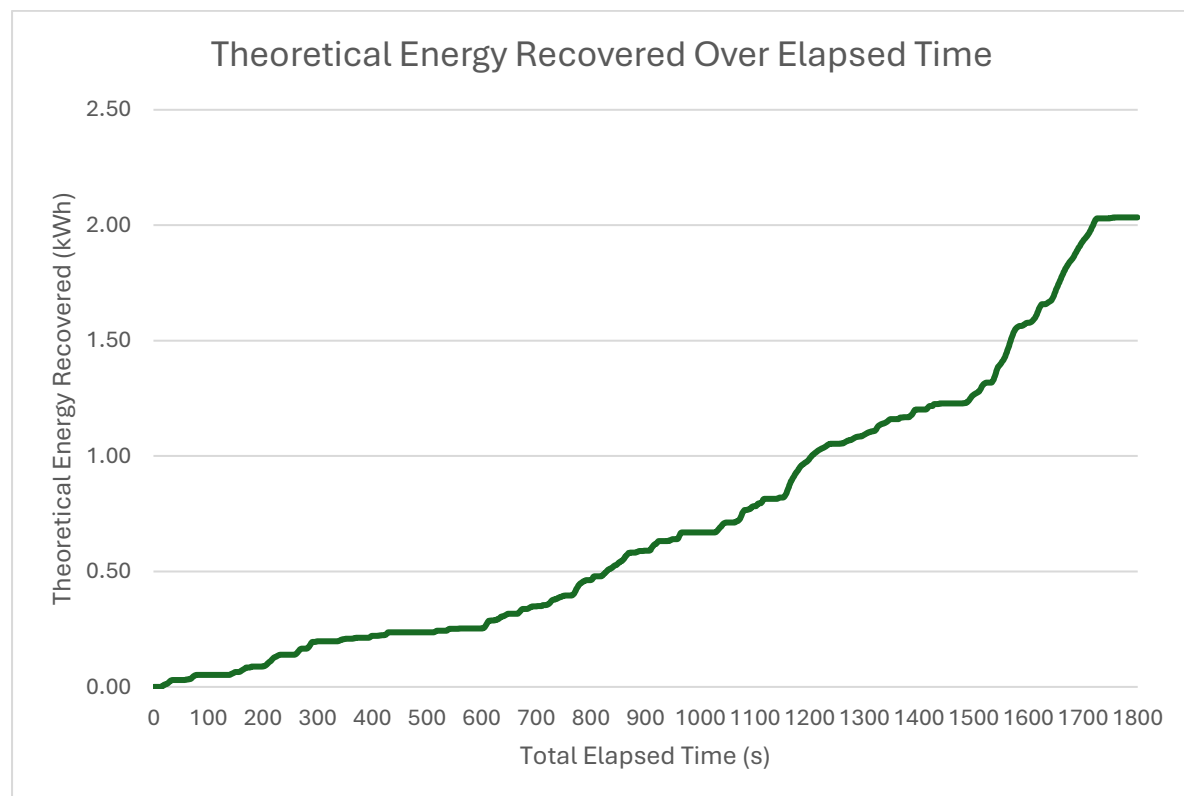
6. Identifying the KERS components and efficiency

The efficiency of a heat energy recovery turbine in an engine varies significantly, but can achieve substantial gains, with some studies showing fuel efficiency improvements of 4–10% and power output increases of up to 10%. Advanced combined-cycle gas turbine systems can reach an overall system efficiency of 55-60% and up to 75-85% in cogeneration mode. Individual waste heat recovery systems can also have their own efficiencies, with one study on an Organic Rankine Cycle (ORC) system reporting an efficiency of 12.12% which boosted the total system efficiency to 44.13% (Ahmadi, M.H. et al, 2022). We will be looking at the Advanced Combined-cycle gas turbine systems and for our calculations on what energy can be recovered we will be looking at the ideal efficiency of 60%.

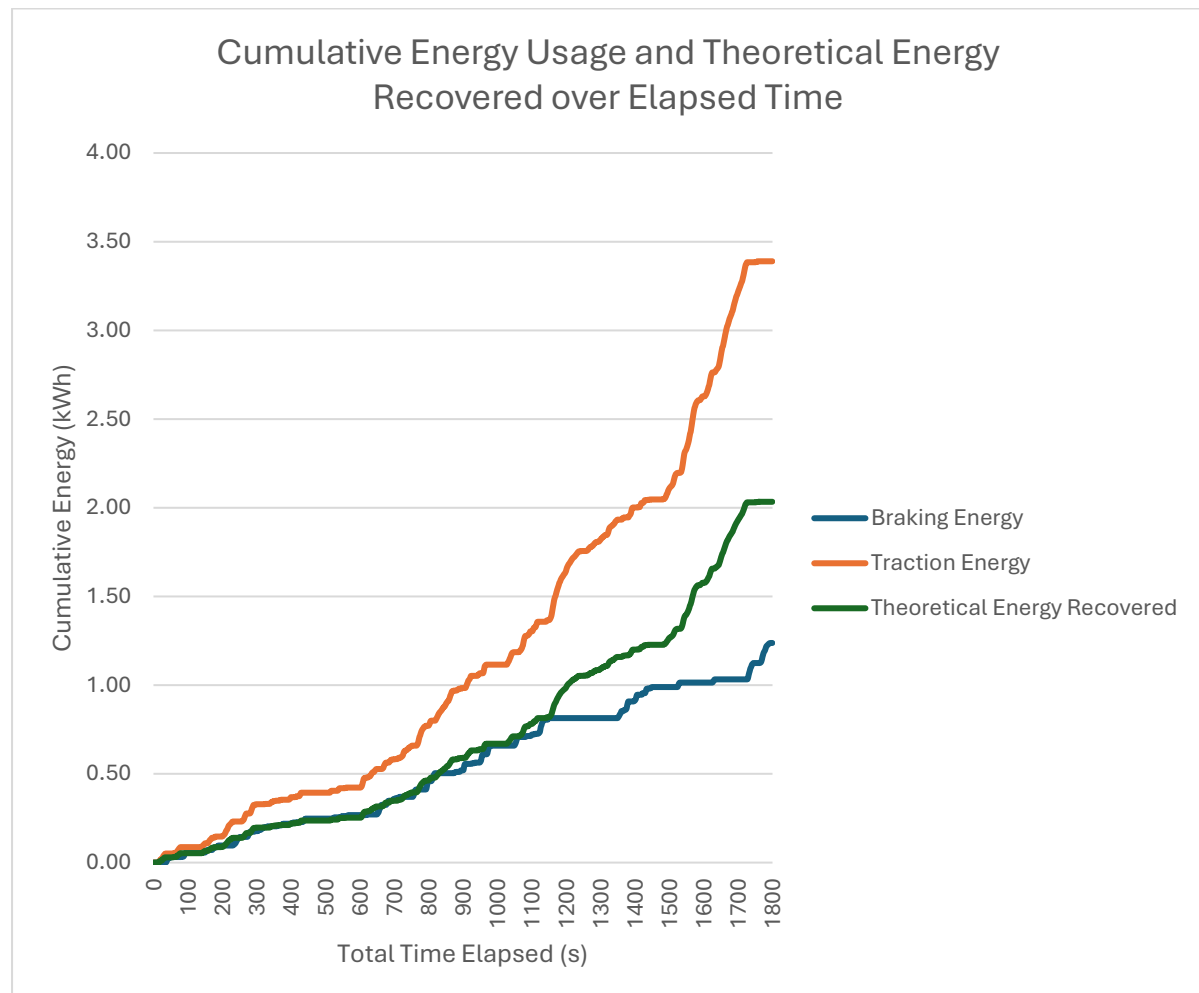
Considering this would practically perform as a mild hybrid it is ideal to look at current mild hybrid cars currently on the market when looking for an ideal battery size.

Considering the battery would ideally replace the small amount of space underneath the false floor of the boot in a VW Arteon we are very limited on size. A close comparison for would be the battery that is found in the mild hybrid Nissan Qashqai which is a 1.97 kWh battery with a flat profile estimated to be no more than 200mm in height. The redeployment would come from an electric motor on the rear axle to reduce the distance from the battery lowering the need for large high voltage cables to run back and forth down the length of the car.

7. Kinetic Energy Recovery



The graph above shows the theoretical Energy Recovered over elapsed time in isolation; this graph shows that whilst the vehicle is on throttle that it recovered energy through blown exhaust gasses. This is mainly theoretical as the efficiency value used assumes a 100% open throttle.



The graph above shows theoretical energy recovered in comparison to the braking energy and the traction energy. This graph shows that the theoretical energy recovered follows the trend of the on-throttle traction energy.

This system intends to redeliver the recuperated energy seamlessly when returning to throttle giving the VW Arteon a small push to cover the short period while the turbo spools back up to its efficient speed. When looking from the perspective of performance this small motor boost, although it would add extra mass to the car should allow the VW Arteon to feel “punchier” and more like a naturally aspirated car when returning to power after periods of off throttle.

References

Ahmadi, M.H. et al, (2022) *Power enhancement of a turbo-charged industrial diesel engine by using of a waste heat recovery system based on inverted Brayton and organic Rankine cycles*

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