

University of Wales Trinity Saint David

Wales Institute of Science & Art



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Academic skills ACHA4005

Suphakit Pratt

2203284

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1 Introduction

This report will be looking at the implementation of hybrid technology in different motorsports series.

1.1 Objective and Aim

This report aims to find out how different motorsports series are using hybrid technology. The objective of this report is to find out why different motorsports are implementing the use of hybrid technology and the advantages and disadvantages of implementing them by using the internet and articles from reputable and trusted sources.

1.2 Justification

- Motorsports have increasingly adopted hybrid systems for several reasons, reflecting a broader trend in the automotive industry toward more sustainable and energy-efficient technologies. Here are some key reasons why hybrid systems are used in motorsports:
- Efficiency and fuel economy – Hybrid systems can improve overall fuel efficiency, its important in motorsports where teams aim to maximize performance while adhering to the regulations that often have rules on fuel consumption limits.
- Environmental concerns – With growing global emphasis on environmental sustainability, motorsports organizations are under pressure to reduce their environmental impact.
- Performance enhancements – Hybrid systems can enhance the overall performance of a vehicle by providing additional power when needed. The electric motor can help the ICE during acceleration, improve torque delivery, especially with force induction cars primarily turbocharged cars and recover energy during braking, this contributes to better overall performance on the track.

2 Background

2.1 Types of hybrid systems

Hybrid technology combines internal combustion engines (ICE) with one or more electric motors, there are different types of hybrids, and each has advantages and disadvantages.

parallel hybrid - The most common configuration combines the two power sources by connecting the gasoline engine and electric motor(s) through a shared gearbox. There are three different types of transmissions available: continuously variable (CVT), manual, and automatic. The acceleration, feel, and sound characteristics of a parallel hybrid are mostly determined by the type of gearbox and the size of the engine.

series hybrid – in this design the electric motor(s) provides the thrust. There's never a physical mechanical connection between the engine and the wheels. The ICE is just there to recharge the battery. This results in a driving experience that's more like an electric car, with smoother and powerful acceleration.

Plug-in hybrids – is an improved version of the conventional hybrid system, with a larger battery pack that requires an external energy source to fully recharge, just like an electric car does. This increased energy storage capacity is comparable to a bigger petrol tank: It can drastically cut fuel usage and enable longer all-electric driving ranges the electric motor would be on most of the time if you have a short commute and recharge every night. If the all-electric range is exhausted, the vehicle essentially becomes a traditional parallel hybrid.¹

¹ Riswick, J. 2019. What is a Hybrid Car and How Do They Work? Available at: <https://www.caranddriver.com/features/a26390899/what-is-hybrid-car/>.

2.2 History

The first implementation of a hybrid race car was in 1998 at Le Man with the Panoz Q9 nicknamed Sparky. The idea behind using a hybrid system was to reduce the amount of pit stops thus greatly increasing the chance of a strong finish in the race. However, the technology that was available in 1998 the battery pack added almost 200kg more than the standard car, meaning that the car was off pace by 12 seconds off the best time of the standard car.²³



Figure 1 Picture of the Panoz Q9 taken by John Brooks (1998)

2 Siregar, A. 2018. Gallery: History of hybrid cars in motorsport. Available at: <https://us.motorsport.com/general/news/gallery-history-of-hybrid-cars-in-motorsport-1008621/1393287/>.

3 Discussion

3.1 Formula 1 (F1)

F1 introduced hybrid power units in 2014 as an effort to align with global trend towards sustainability, energy efficiency and environmental responsibility. the implementation of the hybrid power unit marked a significant departure from the previous v8 naturally aspirated engine. The reasons for introducing hybrid power units in F1 is to show the relevance and adaptability of motorsport to emerging technologies that prioritize fuel efficient and reduce carbon emissions. Also, the move to hybrid technology has attracted the interest of automotive manufacturers that are investing into hybrid and electric vehicles, having manufacturers involved in f1 enhances the technical competition and it also attracts more sponsor and partners interested in environmentally conscious technology.⁴

Advantage	Disadvantages
Efficiency and sustainability – there are two hybrid systems called the Energy recovery system (ERS) which is allied to the 1600cc v6 ICE, one recovers kinetic energy of the car under braking (ERS-K), and another recovers the kinetic energy of the turbo charger- the system allow an F1 driver to have around 1000hp whenever its needed. With a little extra available for qualifying. Despite the huge output it burns just 110kg of fuel in a race, a third less than the last v8's. ⁵	Cost- the development and implementation of hybrid power units in f1 is extremely expensive. This can create a financial barrier, making it difficult for smaller teams to compete at the same level as larger and more financially robust team.
Performance- the hybrid enhances overall performance by additional power boost when need, such as during acceleration or overtaking. In terms of power, the ERS system is capped at 161hp (120kw) so the v6 produces nearly 850hp despite its lean fuel supply.	Complexity – hybrid systems add complexity to the overall design of the f1 cars. This complexity can lead to more points of failure and maintenance challenges.
Strategic racing- hybrids systems add an extra layer of strategy to races, teams must manage their energy usage throughout the race.	Noise and Fan's reaction- some traditional; fans argue that the hybrid systems have led to a quieter race compared to the older F1 cars also traditionalist who feel that the sport has moved away from it roots.

Figure 2 table above shows some of the advantages and disadvantages if implementing hybrid system into F1.

³ Turner, K. 2021. Turbo-hybrid F1 engines: In defence of the 'quiet' beasts. Available at: <https://www.autosport.com/f1/news/turbo-hybrid-f1-engines-in-defence-of-the-quiet-beasts/6043352/>.

⁴ Scarborough, C. 2020. Hybrid F1 power: how does it work? Available at: <https://www.carmagazine.co.uk/hybrid/how-f1-engine-works/>.

3.2 World Rally Championship (WRC)

WRC has explored the use of hybrid technology to enhance the performance of rally cars. The FIA, which governs WRC, has been working on introducing hybrid power units to improve efficiency and reduce emissions. Since the start of 2022 season Schaeffler subsidiary compact dynamics has supplied all the manufacturers in the WRC with a hybrid system, the system is intending to achieve greater safety and equal opportunity, but also promote the development of sustainable drive systems in the championship. The hybrid system consists of a battery with a 3,9-kWh capacitor from Kreisel Electric, motor generator and steering unit which is housed in the smallest areas and weighing only 87kg and being installed transversely in the Rally1 cars. The first time in WRC's history, Rally1 cars can run exclusively on electricity in the service areas. On the stages, the drivers can use the hybrid system to produce extra 100kw which briefly brings the output of the car to 386 kw and thus over 500 hp. The energy is recovered by recuperating braking energy, that way the drive battery is charged while the car is moving. ⁶

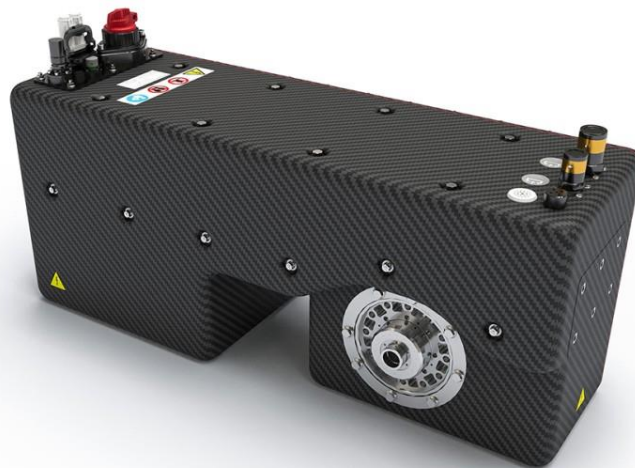


Figure 3 The hybrid system from Compact Dynamics combines a motor-generator, control unit, and a battery with 3.9 kWh capacity in a very small design envelope. ⁷

⁵ Start of a new era: World Rally Championship starts with hybrid system. [no date]. Available at: <https://www.schaeffler.com/en/technology-innovation/motorsport/why-we-race/rallye-wm-hybrid-system/>.

⁶ Hybrid system from Schaeffler subsidiary Compact Dynamics revolutionizes World Rally Championship. [no date]. Available at: <https://www.schaeffler.com/en/media/press-releases/press-releases-detail.jsp?id=87764289>.

4 Conclusion

In conclusion, the widespread implementation of hybrid systems in motorsport series can be linked to many reasons mainly to the ever-growing emphasis on sustainability, technological innovation, and the pursuit of greater efficiency in the automotive industry. As the world focuses on environmental concerns and a shift towards cleaner energy sources, motorsports serve as a crucial testing ground for innovating technology that can eventually get implemented into mainstream vehicle. There are advantages to implementing hybrid systems these can be seen in formula one, WRC and other series such as WEC. The advantages are increase in performance this could be seen in WRC, the drivers can use the hybrid system to produce extra 100kw which briefly brings the output of the car to 386 kw and thus over 500 hp. Also fuel efficiency, despite the f1 producing 1000hp it output it burns just 110kg of fuel in a race, a third less than the last v8's.

However, there are some disadvantages with implementing hybrids systems. Such as cost and increase in complexity. These disadvantages can be seen in Formula. But WRC and LMDH solves this issue by having one company to produce the hybrid system and battery, which is made to meet that class specification and regulations, this reduces the cost drastically because the teams wouldn't have to research and develop their own hybrid system and battery.

In summary, implementing hybrid systems in motorsports series is a good thing because there is more positive outcome to implementing them, such as sustainability, technological innovation, greater efficiency, and an increase in performance capabilities.

5 References

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Hybrid system from Schaeffler subsidiary Compact Dynamics revolutionizes World Rally Championship. [no date]. Available at: <https://www.schaeffler.com/en/media/press-releases/press-releases-detail.jsp?id=87764289>.