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Research on the formula series with green energy resources drive system

Xiyun Liu

Shanghai Datong High School, Shanghai, 200011, China

hopestar_tz@163.com

Abstract. Formula E is a kind of racing that combines green energy use with high-speed racing. From the organization's methods and the technological achievements of recent years, it shows the potential for zero emissions of carbon dioxide. The situation now is optimal and with a clear future (actual plan published by FIA), it shows lots of events still need to improve to achieve the goal. The essay wants to achieve a balance between zero emissions and the observability of racing. So first, the essay focuses on the Formula E, its plan, and its GEN-3 racing car's data. The essay also collects the models of the newly developed hydrogen racing car and nuclear-power racing car. Using this data, the essay concludes that it is better to only focus on Formula E recently, but there is still a larger potential for other driving systems.

Keywords: Formula E, green energy, drive system, formula series.

1. Introduction

Formula car is the cycle racing that built under collective formation and rules. From the 1950s' first formula race to Hamilton's seven champions in the 21th century, the cars were always driven by fossil fuel and traditional engines. The cracking sound of the engine is one of the main draws to attract millions of fans, with some interesting jokes like GP2 Engine generated from this rule. With the increasing international focus on the environment and the debate fossil fuel, FIA (Fédé ration Internationale del'Automobileis) now willing to find a long-run environmentally friendly solution. Although they first put their efforts on changing Formula 1, which means to increase the use of green energy resource including the using of ERS, DRS and biofuel mixed fuel instead of fossil fuel, they failed to do so because it is difficult to less depend on fossil fuel. With EVs (electric vehicles) becoming popular as a result of policy and advertisement, in last ten years, a kind of formula race called Formula E was created and came in public sight. Instead of using tradition fossil fuel, the car uses electronic driven system. This paper is going to use reliable resources from official documents, believable websites and essays (sustainability and management in motorsports, etc.) to research the race and its potential.

2. The organizational analysis of Formula E

2.1. The case of formula E

Formula series are like a high-speed game of chess, which Formula E is also based on. The average racing time of FE is about 45 minutes with average speed at 200 mph [1]. The racing, packed with high-speed action, needed professional drivers like De Vries, who is both a Formula 1 driver and a Formula

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E champion. However, there is still a lot of difference between F1 and FE. First, the car's structure changes, mainly including braking system and drive system. All cars on the grid have same chassis and battery, and only the difference between team's strategy and drivers' skills will be counted. There are also hydraulic brakes without gears combined with the most advanced electric dynamical gearing to help maintain speeds in the corner and recover speed after harsh braking. Second, F1 usually has special circuits which are not available in FE. Racing on the city streets of the world's greatest cities is a creative idea in FE. The city roads that we used in our daily life will be the place to race, like the Monaco circuit. Third, the racing strategy is changed. No wheels will change during the race. Instead, drivers change a new car with new tires and full charged battery in the pit lane. It is a truly zero emission and environmentally-friendly racing that the change the history of pollution in motorsports.

2.2. The organizational development of formula E—motivation

Formula E exists to accelerate sustainable human progress through the power of electric racing. The only sport certified net zero carbon since inception, Formula E was founded to counteract climate change by accelerating the adoption of electric vehicles [2].

Motorsports like F1 or WRC, racing is for legacy and game winner, but this is not the purpose of FE. Instead, Formula E introduces a structure that makes the race as a tool to debate the global climate. That is promoting small holding business to a larger construction to advertise the development of EVs or to lead a much greener or cleaner driving construction style. Organizing the race into a business with no profit rather than a sport, rather than a racing activity but as an experiment of electric vehicles, FE switches its goal from the profit-sharing partnership in F1 by earning from fans' tickets to purpose-sharing partnership of holding brands and technological development. This way makes the championship as a start, an agreement between parties, rather than the final product. Therefore, with the advanced technology gained from the race, the company may win in commercial competition. As a result, more companies will enter the race to provide data and their own trials to increase the attraction of their EVs. And these two events will finally enter a positive loop, which will finally achieve the motivation of FE one day.

2.3. Racing for cleaner future—situation

To reach their goal, FE officials collect their total CO_2 emissions every season to clearly show the improvement of their racing.

According to data collected by FIA, the overall season 7 emission is only 19600-ton CO_2.

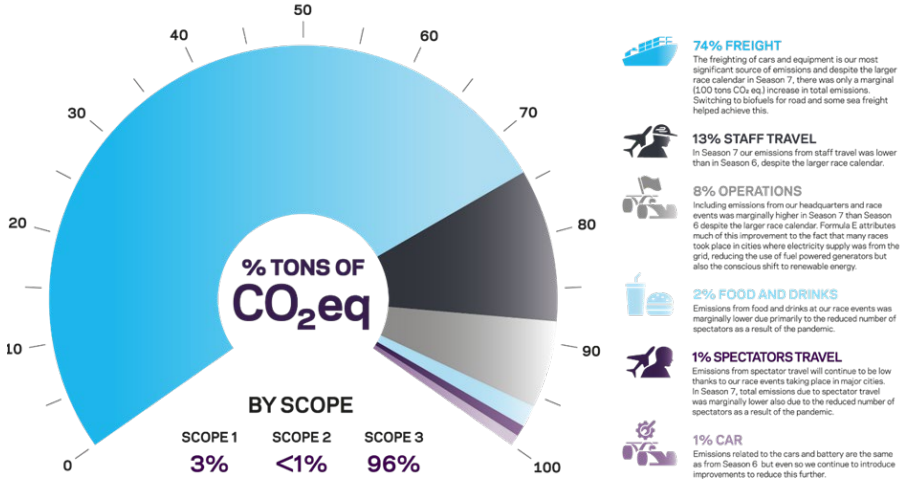

Figure 1. The distribution of carbon dioxide emission in FE 2022 season.

The extraordinary CO_2 emission mainly contributed by following reasons, according to the Figure 1 [3]. First, there was a large cut in staff according to the policy of the 2022 season; there was a much smaller budget for every team than in the 2021 season. All teams made cuts to meet the budget. As a

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result of a smaller travel flow, less transportation means fewer CO_2 emissions. Second, the main distribution in operation fields to ZERO emissions is the street race. For traditional formula races, most of the races are built on an artificial, special, independent circuit, which means that at no race week, the circuit is only a waste place. However, there still needs to be a large amount of human maintenance; more energy consumption is needed and wasted for the race. The FE race changes this situation. By driving on the road, even when there is no race week, the operators could be used on daily transport. This causes fewer CO_2 emissions. Additionally, when choosing the road to race, the FIA aims to place it near the electric generator, like Peking Circuit, which is near the generator built for Olympics Games 2008. Reducing the waste of electricity and the use of fuel also makes a conscious shift to renewable energy. Third, the pandemic also contributes to part of the reduction in emissions. For the last year, most spectators chose to watch the race online. For this reason, spectators' travel emissions and diet emissions are reduced. Fourth, the most important thing is that the car is improved into a new era, achieving Gen 3.

3. The technological analysis of Formula E

3.1. The evolution of EVs In Formula E

Eight years ago, when five red lights were hung on the street in Beijing, the race began. With the screeching noise, 20 Gen1 cars ran on for the first time. Eight years later, after millions of trials and adaptations, the electric technology has improved immeasurably, with the goal of reducing pollution in all aspects.

Back in 2014, Gen 1 cars only produced a humble 200 kW. With the renewable battery technology, Gen3 could produce cars with 350 kw of power in 2022. There is a 75 percent power increase from Gen 1 to Gen 3. What this means is that Gen3 only needs 3 seconds to reach 100 km/h from rest and approximately 7 seconds to reach 200 km/h. Second, the top speed improved. As in Formula 1, the aerodynamics of the car were improved season by season. A greater top speed of 95 km/h is gained by Gen3 over Gen1. This improvement gives the race extreme motion. Third, the most useful part to reduce energy consumption is the regenerator at the brakes. With a new, bolder look and enclosed front wheel arches, the saving effectiveness is greatly improved, from 100 kw per race to 600 kw per race. The six-times power regeneration capability reduced the electricity consumption per race and reduced the emission of CO_2[4].

With more larger manufacturers like Porsche, DS, Audi and McLaren committed to the race, the global series continues to showcase the very best in all-electric technology more widely. The cause is an increasing population of people who bought EVs, from 500k in 2014 to 6.6 million in 2021. The popularity of the race affects the improvement of the EVs and the popularity of the cars, but also with the up trends of electric energy, more big constructors are willing to join the race and research for data and technology of electric energy. In turn, the result is a large improvement of the air condition in these cities. Approximately, in 2023 seasons, 10 cities in the world will be out of air pollution due to the increasingly purchasing of participant constructors' cars [4].

3.2. The case of Audi E-Tron FE05

The Audi e-tron FE05 is a pure electric racing car and a successful successor to Formula E racing. In the future, the Audi e-tron FE05 is expected to defend its honor on the field and strive to defend its title in the fifth season of Formula E. In the document, the Audi FE05 is an absolutely powerful Gen2 racing car, laying a solid foundation for the Gen3. The Audi FE05 has a maximum speed of 240 kilometers per hour, a power output of 250 kilowatts, and accelerates to 100 kilometers per hour in 3.1 seconds during rest. According to data collected by Audi officials, carrying the Audi Schaeffler MGU 03 electric generator equipment and McLaren's ESS and lithium batteries to restore charging capacity, this car achieved its expected goal at a weight of 900 kilograms (one-third of which is the battery, including the driver's weight), and can charge 52 kilowatt hours in just 45 minutes [5].

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Audi is committed to electric mobility. By 2025, it is expected that one out of every four Audi cars delivered will be electric. Prior to this, the Audi brand will launch over 20 electric and plug-in hybrid vehicles, covering all markets and models. The first model launched in 2018 was the sporty Audi e-tron SUV, with a range of over 500 kilometers. By 2020, Audi will expand its electric products through compact models. Starting from 2021, it is planned that all core models will be electrified, including mild hybrid technology. By 2025, one-third of Audi's models will be electrified, whether they are pure electric or plug-in hybrid. From the Audi 80 Avant plug-in hybrid model to the later Audi A6 hybrid model, Audi A3 Sportback e-tron, and today's Audi e-tron FE05, Audi has closely followed the trend of new energy development in every era, striving to provide users with the cleanest and most technologically advanced products in every era. In the future, with the deepening of the "sustainable" development strategy, Audi will accelerate the research and development of new technologies and achieve mass production, making safe, reliable, and efficient new energy a choice for more people. The road-to-road achievement of applying FE technology to daily transportation not only occurs in Audi, but also in all builders such as the Nissan Leaf series. For everyday drivers, the range of the Leaf has increased by 184%, from 135 kilometers in 2014 to 384 kilometers in 2022. This means that a single charge can cover more miles, making electric vehicles a realistic alternative to internal combustion engines for commuting and long-distance travel.

4. The potential discussion of Formula Series

4.1. Discussion of Formula E

According to a report by a Formula 1 fan on Twitter, FE is a totally awful race. The embarrassing narrow street race, an odd engine noise, and a ridiculous "car changing" pit lose the excitement of the formula race. The paper believes that FIA is overly conscious of environmental protection. It is important for the FIA to find a balance between investment from fans' tickets and technological improvement for the future. The trend to lower the emission of pollutants is right, but too much action in a season may cause the race into a trough.

To meet the balance, Formula E gives four aspects to improve: Freight, Suppliers, Transportation, Waste. These processes indicate one thing. The International Automobile Federation will achieve balance by strengthening the reduction of the use of non-zero (zero emission) objects that cannot be represented in the sight of fans, and increasing the number of seasons matches. The paper estimates that by 2026, the FE competition will achieve the goal of carbon neutrality and achieve true zero emissions.

4.2. The potential of Formula 1

Whatever the sport, Formula 1 is always the most attractive racing sport in the world. FIA and lots of host countries collaborate to achieve an environmentally friendly solution in Formula 1. The main distributor is Car Improvement. Due to the high speed of F1 racing cars, their fuel consumption is much higher than that of regular cars. However, upon careful consideration, if it weren't for such high noise and energy consumption, we wouldn't have seen such a wonderful competition. In addition, when people criticize the pollution of F1 racing cars, they may also overlook the fact that many new technologies in the automotive industry are first used on F1 racing cars before being put into civilian cars; And these new technologies actually include many environmentally friendly technologies. That is to say, F1 racing cars are actually technological pioneers in the environmental protection industry. In 2014, FIA stipulated that the maximum displacement of F1 racing engines should be reduced from 2.4L to 1.6L. This means that the fuel consumption of each vehicle is reduced by about 30%, making it a huge leap. To ensure the speed of the racing car, this means that the car needs to draw energy from other sources or reduce its own energy loss - obviously, the latter is more realistic than the former. A major application of racing cars to reduce their own energy consumption is the turbocharger. If there is no turbocharger, the combustion exhaust gas will be directly discharged from the engine into the atmosphere. After having a turbocharger, it will use the energy of exhaust gas to drive its own blades to rotate, sucking in more air from the surrounding environment to provide the engine with more complete combustion of fuel. In this

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way, combustion heat is successfully used to improve fuel combustion efficiency and provide more energy to the racing car. So, this is a great application for vehicles to reduce their own energy consumption. Turbochargers reduce the energy consumption of racing cars, so is there any other way? The extremely high driving speed of F1 racing cars brings great air resistance to their progress. Therefore, the shape design of a racing car is particularly crucial: how do you design a car that has good stability and grip while also reducing air resistance? The F1 team has invested a lot of money to cooperate with universities and companies to carry out computational fluid dynamics research and wind tunnel experiment exploration. This not only improves the shape of racing cars, but also promotes the development of science and drives breakthroughs in other industries. In 2010, the International Automobile Federation stipulated that F1 cars should not refuel repeatedly during races. That is to say, the racing car needs to use the initial amount of fuel in the fuel tank to complete the race. The improvement of fuel combustion efficiency has become particularly important. In this context, this new regulation not only promotes improvements in engine design, but also promotes fuel optimization, such as adding additives to the fuel. This improved fuel can effectively reduce the friction between the engine piston and cylinder block, while also helping to clean up accumulated impurities in the cylinder body and improve engine efficiency. Total Group and Lotus team have conducted research on fuel additives and applied them to F1 racing cars. At the same time, they have also promoted this technology and used it in the fuel of ordinary vehicles [6].

Overall, F1 racing cars do cause greater pollution and energy consumption than regular vehicles, but environmentalists do not have to be biased against this sport. On the contrary, the new technology developed on F1 racing cars can improve the energy efficiency of cars, reduce car exhaust emissions, and be applied to future household cars same as the purpose of FE, making billions of cars around the world more environmentally friendly and improving our living environment from another perspective.

4.3. The potential of applying other energy resources in Formula Series

This year, a car named Carcopter comes up. It is a hydrogen powered Formula One racing car. The most difficult thing to believe is that it is both hydrogens powered and capable of flying, while also being a racing car. This flying racing car is a work exhibited by French startup MACA, and this technology rich product is jointly provided by Airbus executive Michael Krollak and former fighter pilot Thierry de Boisvilliers. Although the original design intention of the two is to replace our familiar fuel F1 racing cars, reduce exhaust emissions, and achieve environmental protection goals, But the Carcopter is still trying to become the first ever human driven flying F1 race car, with a maximum airspeed of 153 mph. However, it is important that MACA only showcases a model of the Carcopter concept car at CES, with a total length of 8 feet. In the future, actual mass-produced cars will be twice the size of this model, weighing over half a ton, with built-in hydrogen tanks and fuel cells that can power six 35kW electric motors. According to promotional data, this flying racing car has a longer range than regular electric cars and may have autonomous driving assistance. This technology is gradually maturing, and it will soon be applied to Formula 1. Just from the data and situation now, fortunately, hydrogen is likely a feasible solution. So it is better for constructors to do a trial on an electric-hydrogen hybrid formula car first [7].

The idea of a nuclear reaction in a dynamic car has been long thought of. Just from the situation now, this program is not so much feasible as a final goal or a perfect goal we need to achieve. To use this technology in the formula race, we need to solve the problems of the storage of heavy nuclear fuel and the protection of reactions to avoid damage. However, because of the lightness that a Formula 1 car needs and its high potential to crush during the race, these two problems may be further developed in the Formula 1 series. It is better for us to start researching materials first, not the driving system [8]. Also, if this comes true one day, it will not be so useful because it generates too much energy than a normal formula race needs.

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5. Conclusion

In a positive aspect, FE is a positive cycle for the electric dynamic's fields. More constructors are participating in the race to get the data needed to meet the government's encouragement of using EVs. Then, more data from the race will attract new constructors to participate. The FE race leads the technology of electric transportation, and the market for EVs increases the popularity of the race. Using a sports game, the FIA successfully enhances the status and attention of the EVs. This trend helps to protect the atmosphere. Technological improvement also attracts more people or businesses to concern for the environment and encourages the development of EVs to speed up the circle of FE. The future of FE is clear and achievable. However, as someone doubts that it is still not a longer conservation program, it is better to choose other solutions. Most likely, hydrogen is a perfect choice. With its feasibility and high utility, it may be the first choice for engineering researchers. However, it is still too early for us to consider this technology, for it is still in the planning stage. So it is better for us to choose the combination of formula series and green energy resources because it is more likely to be achieved. The truth that Formula One racing is the world's most environmentally polluting sport will no longer exist.

References

[1] Jamie Reigle and FIA, (2022) sustainability report 2022, https://www.fiaformulae.com/en/what-is-formula-e.

[2] Robeers, T., & Van Den Bulck, H. (2018). Towards an understanding of side-lining environmental sustainability in Formula E: Traditional values and the emergence of eSports. Athens journal of sports, 5(4), 331-350.

[3] Formula E Office, (2022) How Formula E Achieves Net Zero, https://www.fiaformulae.com/en/news/2033/how-formula-e-achieves-net-zero.

[4] Formula E Office, (2022) Gen1 to Gen3: The Evolution of EVs In Formula E/ FEATURE, https://www.fiaformulae.com/en/news/1733/gen1-to-gen3-the-evolution-of-evs-in-formula-e.

[5] FE Audi, (2022), About Audi E-tron FE05 https://www.audi.cn/zh/audi_brand/audi_experience_activities/formula-e.html.

[6] Sam Collins, (2022), Formula 1 and the environment, https://www.racecar-engineering.com/tech-explained/formula-1-and-the-environment/#.

[7] Eliane Fiolet, (2021), Carcopter by MACA: First Hydrogen-Powered Flying F1 Race Car, https://www.ubergizmo.com/2021/01/maca-carcopter-hydrogen-flying-f1-race-car/

[8] Næss, H. E., & Tjønndal, A. (2021). Innovation, sustainability and management in motorsports: The case of Formula E (p. 140). Springer Nature.