**Executive Summary of AirDensityDrive: F1 Power & Top-Speed Analysis**

**Aim**

Demonstrate the impact of air density on engine power output, drag force and top speed for a Formula 1 vehicle for current and upcoming regulations.

**Scope**

All 24 tracks from F1 calendar

Ambient conditions at each track

Engine model: Choked air flow conditions

Drag & Rolling-Resistance Physics

**Methodology**

1. Data Collection: Elevation & Average track temperature per circuit
2. Density & Flow Model: Barometric formula + choked flow assumption
3. Power Calculation: ICE LHV x eta combustion +MGU-K contribution
4. Top Speed Solver: Numerical root-finding(fzero) to balance Pdrag + Prr = Ptotal
5. Validation: Comparison with FIA speed data (not all data was available)

**Key Results**

As it can be seen from *Figure 1*, apart from Mexico City, Sao Paulo and Las Vegas, air density ranges around 1.1 to 1.2 kg/m3.

To validate the model, available data from F1 timesheets and online posts have been used. Overall accuracy achieved between the calculated and real values is 95.48%. Apart from Singapore GP, all the observed results are within 10% tolerance band. Obviously, it is naïve to expect cars to achieve these top speeds at every track as some tracks such as Singapore and Monaco does not have the straight line distance to achieve these high speeds. On the other hand, this model uses a constant drag coefficient which considers no DRS and its impact and fuel ratio is also stoichiometric whereas in reality at high RPMs F1 cars utilize slightly rich mixtures to maintain combustion chamber and exhaust temperatures as well as to maximize the power. As a result of this, top speed at Mexico City is higher than the calculated top speed.

and therefore expected power output is also quite similar which can be seen from *Figure 3*. On the other hand, at these 3 tracks in maximum flow conditions maximum engine power drops up to **X** and maximum total available power drops up to 19% than the average. From power stand point, these cars should be slower. However, as it can be clearly seen from *Figure 4*, it is the exact opposite. This phenomena can be explained with the importance of aerodynamics. Explain the drag force

With the increase in MGU-K power output, cars can achieve higher speeds in 2026 especially at tracks with lower air density as MGU-K performance will not be affected compared to the ICE. This is also evident in *Figure 3* where top speed increase is much more substantial compared to the 2025 vehicles. Whether the deploying MGU-K to achieve these speeds are viable or not is out of the scope of this project.

As of 2026, F1 is planning to use 100% fully sustainable fuels. For this study this fuel is assumed to be ethanol as series such as BTCC have already started using ethanol as of 2025. Compared to gasoline which has 14.7 AFR and 44 MJ/kg energy density, ethanol has a 9.7 AFR and 39 MJ/kg energy density. Requiring less amount of air for the same amount of fuel implies that in 2026, more fuel can be burned in the combustion chamber. From *Figure 2*, this changes demonstrate how the power from the engine will be affected.

**A graph showing the number of countries/regions

AI-generated content may be incorrect.**

**Figure 1. Air Density at each track**

**A graph showing the top speed comparison

AI-generated content may be incorrect.**

**Figure 2. Top Speed Comparison with ± 10% Tolerance**

A graph of different types of gas

AI-generated content may be incorrect.

**Figure 3. Maximum Total Power results**

A graph of different types of gas

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**Figure 4. Top Speed results**

Discrepancies between real world and simulation data

**Next Steps**

To make the analysis more accurate, top speed data from each track must be obtained. Additionally, at the end of 2025 and 2026 seasons results should be reviewed to

In terms of discrepancies occurring in tracks like Monaco, conducting a more comprehensive validation by obtaining entrance speed to straight, straight-line distance shed some light.

**Conclusion**

Initial model forecasts a consistent top‑speed uplift under 2026 regs. Full validation pending real data; however, insights will inform aerodynamic setup and MGU‑K calibration strategies.