Lighter EVs will drive the future of mobility

Green transition is truly upon us. The transportation sector is responsible for roughly 25% of the 45 gigatonnes of CO2 emissions globally. Of this, commercial land mobility accounts for about 75%. Today, we agree upon two methods of greening the trucking fleets — using electricity or sustainably-produced hydrogen, with roughly 80% of the grid running on solar, wind and nuclear. Green hydrogen remains too costly to produce (currently ~$5/kg with the target at ~$2/kg), and engines that can run on 3x denser ammonia need to be proven at scale.

Strides made in electric-vehicle (EV) technology have proven successful within passenger segments (cars, buses and motor scooters), with a continuously declining battery pack cost (less than $100/kWh pack in China, 2024), ~94% motor efficiency, intelligent software and machine learning (ML) led optimisation. Within the semi-regulated automotive sector in India, two-wheelers and three-wheelers have shown good potential. But four-wheeler last/middle mile and heavy haul platforms still lag in adoption, primarily due to the high upfront cost. This is a segment where freight rates and delivery timings are under constant squeeze and even the most forward-looking boards haven't been able to justify such high upfront expense that would typically take years for payback.

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So, what's the solution? Rather, what is lacking? As battery densities increase and motor/transmission efficiencies peak, as an industry, we must look towards the third very important factor — vehicle structure efficiency. When diesel gave a calorific value of ~45 Megajoules/kg, cost $1/litre and reported ~25% combustion efficiency, the auto industry didn't have to worry about the vehicle structure. That the average container truck emitted ~225 tonnes of CO2 per year could be merrily ignored, but now with tightened climate scrutiny, the permissible limit is 10x lower, at ~20 tons of CO2 per year, given there are batteries that only give a calorific value of 0.5 Megajoules/kg. And, within the ambit of this calculation, payload and performance must not be impacted otherwise delivery companies lose business.

This seems like an impossible task. But there are parallels with how other industries solved similar conundrums. Take the case of the Airbus A350 and Boeing 787 international jetliners. For decades, the engine industry (GE, Rolls Royce, P&W) funded expensive R&D to decrease the fuel burn by 2-3% on every iteration every five years. All of that wasn't enough to build an economical long-range aircraft until the fundamental fuselage structure got replaced by high-strength composites, leading to a 25% fuel efficiency increase — a massive leap.

Take the case of wind power generation. The 125-metre-long blades built with lightweight composites today create 15 MW power in a single turbine today while surviving hurricane-level wind speeds with warranties that run into decades. This ultimately results in higher power generation efficiency, thus lowering the cost of energy to competitively bid for power purchase agreements with a mere 5-10% profit after tax (PAT). In the near future, anything that moves will need to be lightweight to consume 25-50% less energy, especially when fuels like diesel must be phased out. Within electric trucking, using lightweight structures to reduce battery consumption by 25-50% is the clearest and fastest way to reduce the high upfront costs. That inherently also implies that one must reduce the dead weight from the vehicle without incurring additional costs on materials or capex towards lightweighting.

The last part is not so easy. In automobiles, the industry has lightweighted for high speeds in Formula 1 or high-end sports cars with carbon fibre, but that comes at a high cost of material as well as production (with very few parts produced). The challenge facing the industry is to find cheap enough and recyclable materials (~$3-4/kg), stable prepregs at room temperature, scalable manufacturing techniques like metal die casting or stamping, design-for-repair, design-for-durability and build a new class of platforms for last mile container trucks.

The good news is the engineering community has overcome many of these challenges, building large rockets and aircraft, where the factor of safety is a mere 1.25 or 25% of the peak structural load. Land mobility designs incorporate much higher factors of safety at 4 or 300%, making it easier to build these vehicles for long-term durability and crashworthiness.

It's high time we focused on system efficiency itself to reduce energy consumption. Otherwise, the logistics/delivery economics will never work out, no matter how cheap lithium becomes in the future. Let's innovate and invest before it's too late.

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