**Questions**

1. Evaluate the performance of BEVs vs ICE? What are the major differences?
2. Why are people choosing BEVs? What are the driving factors in the increase of BEV adoption?
3. How effective have these factors been in people switching from ICE vehicles?
4. How impactful have chain disruptions due to COVID-19 been on vehicle sales?
5. What is key price depreciation on vehicle sales? How do these differ with BEV vs ICE?
6. Quantify vehicle mileage for cars:

* Why are people deciding to drive BEV’s less than ICEs?
* How are electricity/gasoline prices impacting mileage?

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| **Research Question:**  Evaluate the performance of BEVs vs ICE? What are the major differences? | |
| Source | Notes |
| International Energy Agency (IEA), the U.S. Environmental Protection Agency (EPA), and various automotive manufacturers provide data | Efficiency   * BEVs: Higher efficiency as electric motors convert more of the electrical energy from the battery to drive the wheels; typically, BEVs convert about 60% of the electrical energy to power at the wheels. * ICE Vehicles: Less efficient, with only about 20% of the energy from fuel going to drive the wheels due to losses in the engine, drivetrain, and other components.   Environmental Impact   * BEVs: Generally produce fewer emissions over their lifecycle compared to ICE vehicles, especially if the electricity comes from renewable sources. However, battery production is energy-intensive and involves critical raw materials. * ICE Vehicles: Produce more greenhouse gases and pollutants due to combustion of fossil fuels. Emissions include CO2, NOx, and particulate matter, contributing to air pollution and climate change.   Maintenance and Reliability   * BEVs: Require less maintenance as they have fewer moving parts (no engine oil, spark plugs, or fuel filters). This can lead to lower operating costs over time. * ICE Vehicles: Require regular maintenance such as oil changes, exhaust system repairs, and engine maintenance, which can be costlier over the vehicle's life.   Driving Experience   * BEVs: Offer instant torque and smooth acceleration from a standstill, providing a responsive and quiet driving experience. * ICE Vehicles: Acceleration depends on the engine size and type; they typically have a more complex transmission system, which can affect smoothness and response time.   Cost of Ownership   * BEVs: Initially more expensive due to the high cost of batteries, but incentives and lower operating costs can offset the purchase price over time. Electricity costs for charging are generally lower than fuel costs for ICE vehicles. * ICE Vehicles: Lower initial purchase price but higher fuel and maintenance costs over the vehicle's lifespan. They may also be subject to environmental regulations and taxes, which could increase costs.   Range and Infrastructure   * BEVs: Range has significantly improved, with many new models offering over 300 miles on a single charge. However, charging infrastructure is still developing, which can be a concern for long-distance travel. * ICE Vehicles: Offer longer range and quick refueling times due to an extensive network of gas stations. This makes them currently more convenient for long-distance and unplanned travel.   Innovation and Future Trends   * BEVs: Rapid advancements in battery technology are expected to continue, improving range, reducing costs, and possibly solving current limitations regarding charging speed and raw material sourcing. * ICE Vehicles: While improvements continue to be made in fuel efficiency and emissions reduction, the global trend is moving towards electrification due to environmental concerns. |
| <https://ele>  ctriccarho  me.co.uk/  electric-ca  rs/bev-phev-  hev-ice/  <https://www.gr>  eenvehicleguide.  gov.au/News/Art  icle/20220908\_N  ews\_TypesOfElec  tricVehiclesExpla  ined | BEV (Battery Electric Vehicle)   * Powered by large battery only * Popular Models: Audi Q8 e-tron, Hyundai Ioniq 5, Tesla Model 3, Polestar 2, Volkswagen ID.3, Kia EV6, Mini Electric, MG ZS EV, Tesla Model Y, Renault Zoe, Hyundai Kona Electric, Kia Niro EV   PHEV (Plug-in Hybrid Electric Vehicle)   * Medium size battery for travelling low miles, than petrol/diesel * Popular: Range Rover Evoque P300e, Ford Kuga PHEV, BMW 3 Series 330e, Cupra Formentor eHybrid, Audi Q5 TFSI e, Hyundai Tucson TGDi Plug-in Hybrid, Jaguar F-Pace P400e   HEV (Hybrid Electric Vehicle)   * Small Battery (takes over at low speeds), ICE otherwise mainly * Battery itself charges partly via ‘regenerative braking’, as is the case also with BEVs and PHEVs. When you press the brake pedal, it makes the electric motor go in reverse and act as a generator. Thus, no Plug-in.   ICE (Internal Combustion Engine)   * Just the normal car   FCEVs (Hydrogen or Fuel Cell Electric Vehicles)   * FCEVs convert fuel into energy through an electrochemical reaction with hydrogen and oxygen. This produces electricity which powers an electric motor. * FCEVs are an emerging technology in Australia and are not yet available for everyday use. |
| **Conclusion**s: Why is this important? Link to hypothesis.  So what? |  |

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| **Research Question:**  Why are people choosing BEVs? What are the driving factors in the increase of BEV adoption? | |
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| General Info form US  <https://www.pnas.org/doi/full/10.1073/pnas.2219396120>  <https://evmagazine.com/mobility/what-factors-drive-electric-vehicle-adoption-globally> | * Battery costs decreased by a factor of ten from 2010 to 2021, BEV range increased by 200%, and efficiency improved by 15%. * By 2030, BEVs could become the majority in car and near-majority in SUV sales due to technology trends and the availability of BEV options for every gasoline vehicle. * Consumer valuation of BEVs, considering price and range improvements, is expected to equal or exceed gasoline counterparts by 2030 * Environmental impact is a significant factor for 38% of consumers choosing EVs, emphasising the desire to reduce carbon emissions. * Potential cost savings motivate 44%, highlighting the economic benefits of lower operational costs compared to traditional vehicles. * Despite infrastructure concerns, Range & Infrastructure were the least concerning for respondents at 4%, indicating growing confidence in charging availability and EV range. * Cutting-edge technology attracts 15% of consumers, showing a strong interest in innovations like bi-directional charging and advanced driver assistance systems (ADAS). |
| [Impact of Government Incetives on Market.pdf](file:///C:\Users\Gunne\Sync\Google%20Drive\Year%205\Thesis\ResearchPaper\Impact%20of%20Government%20Incetives%20on%20Market.pdf)  REALLY GOOD SOURCE | * A study showed that purchase probability for a certain class of customers increased from 0.186% to 0.720% when a subsidy of $3,000–$10,000 was applied. * The effectiveness of subsidies was noted to be greater when applied directly to consumers rather than manufacturers, as they directly reduce the purchase price. * Maximum upfront rebates of $10,000 were most preferred, reflecting the high cost of the majority of EV models, which often exceed $60,000. * The high cost of EVs makes them less affordable for middle-income families, typically earning around $80,000 per annum, underscoring the importance of substantial subsidies to improve accessibility.   Non-Government   * Access to bus lanes for EVs was the only significant non-financial incentive, increasing EV purchase probability by 0.04% for a specific class of respondents but had no positive impact on other classes. * Despite its potential to reduce travel time, its effectiveness was considered lower than other incentives, and it could negatively impact public transport users. |
| [An Analysis of Consumer Incentives in Support of.pdf](file:///C:\Users\Gunne\Sync\Google%20Drive\Year%205\Thesis\ResearchPaper\An%20Analysis%20of%20Consumer%20Incentives%20in%20Support%20of.pdf) |  |
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| **Research Question:**  How effective have these factors been in people switching from ICE vehicles? | |
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| **Research Question:**  How impactful have chain disruptions due to COVID-19 been on vehicle sales? | |
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| <https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=9174793> | * Automotive Parts: Most of the main automobile manufacturers are experiencing production shutdowns in some of their plants in China and other countries. The global output for the automotive industry is expected to drop by 13% [11]. Volkswagen shut down its automotive plants in China due to travel restrictions and lack of parts. General Motors restarted its Chinese plants but at a very lowproduction rate for basically the same reasons. Hyundai shut down its assembly plants in South Korea, mainly due to shortages of parts from China [12]. Nissan factories in Asia, Africa, and the Middle East halted their production [13]. **Fix Up and Australia Impact**2 |
| <https://business.carsales.com.au/research/covid-19-automotive/>  This is a bit more impact of COVID on carsales rather than supply | Increase in Car Usage   * A July 2020 carsales survey revealed that 81% of Australians are more likely to use their cars due to concerns about hygiene, contact with others, and convenience amid COVID-19.   Non-car owners   * In July 2020, 63% of non-car owners, up from 58% in April 2020, indicated in a carsales survey they were more likely to consider buying a car due to hygiene concerns related to public transport and ride-sharing.   More Licence Holders   * In July, 47% of surveyed new licence holders agreed that COVID-19 accelerated their decision to get their driver's licence due to public transport and hygiene concerns.   More Consumer Readiness   * 27.9% of respondents in a September 2020 carsales survey indicating they were 'ready to buy now,' an increase from 26.8% in July, 20.6% in May, and 16.8% in April.   Superannuation   * In April, the Federal Government introduced new support for consumers affected by COVID-19, allowing early access to two $10,000 portions of their superannuation in FY20 and FY21, leading to an immediate increase in demand for affordable cars on carsales. * Carsales reported a 15% growth in enquiries for used cars under $10,000 in April 2020 compared to April 2019, reflecting the impact of the government's announcement. |
| <https://alphacashforcars.com.au/impact-covid-19-used-car-market/> | **To Add** |
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| **Research Question:**  What is key price depreciation on vehicle sales? How do these differ with BEV vs ICE? | |
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| <https://carchase.com.au/resources/car-valuation-guide/car-depreciation-explained/> | Factors influencing Car Depreciation   * Age of the car – The older a car is, the less value it has. The physical appearance and mileage of a vehicle are used to calculate its age. * Fuel efficiency – Fuel-efficient cars are cost effective and have more long-term resale value. * Make and model – Car brands like Toyota, Mazda, Ford and Honda are popular choices in Australia. SUV models are especially in high demand, which increases their market value. * Quality of maintenance – The better maintained a car is, the slower its depreciation will be, especially if records of its maintenance are available as proof. * Condition of the vehicle’s interior and exterior – Modifications such as tints, leather interior and a surround sound audio could improve a car’s value. * A table from RACQ is also provided on the website with depreciations |
| <https://www.canberratimes.com.au/story/8423709/how-much-more-electric-cars-depreciate-than-petrol-diesel-or-hybrids/> | **To Do** |
| <https://apo.org.au/sites/default/files/resource-files/2018-05/apo-nid172091.pdf>  Government Source | * EVs have higher purchase costs than conventional vehicles. * Lithium-ion batteries contribute to approximately 50% of the cost difference between EVs and conventional vehicles. * Since 2011, the cost of lithium-ion batteries has decreased, with further declines expected due to increased production and technological advancements. * Price parity between EVs and conventional vehicles is anticipated to occur between 2023 and 2030. * EVs depreciate faster than conventional vehicles; for example, a petrol vehicle retained 55% of its value over five years, compared to 43% for an EV. * Factors contributing to faster EV depreciation include rapid technological advancements and concerns over lithium-ion battery longevity. * Lithium-ion batteries typically have a lifespan of 8-10 years, but their longevity varies based on battery characteristics and operating conditions. * "Range anxiety" and limited charging infrastructure are significant concerns for EV adoption, contrasting with the convenience of refueling conventional vehicles. * Surveys indicate consumer concerns over the driving range of Battery Electric Vehicles (BEVs), exacerbated by the current shorter range of EV models compared to conventional vehicles |
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| **Research Question:**  Why are people deciding to drive BEV’s less than ICEs? | |
| Source | Notes |
|  | * Range concerns * BEV’s have lower range on single charge compared to ICE. This is a key factor for those wanting to travel long distance * Charging infrastructure * Inadequate in areas * Also time consuming |
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| **Conclusion**s: Why is this important? Link to hypothesis.  So what? |  |

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| **Research Question:** How are electricity/gasoline prices impacting mileage? | |
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