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Environmental Data Analytics · Academic Project

EV Adoption Environmental Impact Analysis

Dual-database pipeline correlating 200,000+ EV registrations with AQI improvements across Washington State counties.

200K+	MongoDB + PG	23%	18 months
EV Registrations	Dual Database	AQI Improvement	Impact Lag Found

TOOLS & TECHNOLOGIES

Python	MongoDB	PostgreSQL	Pandas	Matplotlib	Seaborn
REST APIs	Folium				

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PROBLEM STATEMENT

Policymakers debate whether EV adoption materially improves local air quality or simply shifts emissions upstream to power generation. A common objection is that EVs reduce tailpipe emissions but increase power station output. This project built a data pipeline to correlate actual EV registration data with EPA air quality measurements at county level to provide evidence-based answers.

DATASET

Two primary data sources integrated via a custom ETL pipeline: EPA AQI (Air Quality Index) monitoring station readings across Washington State counties, and Washington State Department of Licensing EV registration database. King County alone contained over 200,000 EV registrations. Data ranged from 2015 to 2023, enabling multi-year temporal analysis.

APPROACH & METHODOLOGY

Built a dual-database ETL pipeline — MongoDB for semi-structured EPA JSON monitoring data, PostgreSQL for structured registration records. Temporal correlation analysis measured annual EV adoption rates against county-level AQI trend lines. Population growth and county-level industrial output were incorporated as control variables to reduce confounding. Geospatial Folium mapping visualised county-level EV penetration versus AQI change over time. Lag analysis tested AQI response windows from 6 to 36 months post-adoption increase.

KEY TECHNICAL HIGHLIGHTS

› Dual-database ETL pipeline integrating MongoDB (EPA JSON feeds) and PostgreSQL (DOL registration records).

› King County showed a 23% improvement in average AQI scores concurrent with EV adoption growth to 8%+ penetration.

› Lag analysis identified an 18-month gap between EV registration increases and measurable AQI improvement.

› Population growth and industrial activity included as control variables to reduce confounding.

› Interactive Folium map visualises county-level EV penetration vs AQI change across all Washington counties.

› Pipeline designed for incremental monthly updates from both EPA and DOL data feeds.

KEY INSIGHTS & RESULTS

Counties with EV penetration above 8% showed statistically significant AQI improvements averaging 12 AQI points reduction. The 18-month lag reflects the fleet replacement cycle required before air quality benefits materialise at scale. Rural counties showed lower EV adoption rates and lower baseline pollution, making direct urban/rural comparisons complex.

BUSINESS IMPACT

Provides quantitative evidence for EV policy advocacy at county level. Demonstrates that EV incentive programmes in high-density urban counties deliver the greatest measurable air quality return per registered vehicle. The 18-month lag finding informs when air quality benefits should be measurable following an incentive programme launch — useful for policy evaluation timelines. The framework is replicable across other US states with comparable open data availability.
