BUSINESS NEED

The data

The excel datafile comprises hourly Interstate 94 Westbound traffic volume for MN DoT ATR station 301, roughly midway between Minneapolis and St Paul, MN. The data ranges from November 2012 to September 2018 and includes attributes such as weather features and holidays to determine impacts on traffic volume.

Problem definition

"In 2007, Governor Tim Pawlenty signed the bipartisan Next Generation Energy Act into law, setting statutory goals to reduce greenhouse gas (GHG) emissions by 15% from 2005 levels by 2015, 30% by 2025, and 80% by 2050." Minnesota couldn't reach its goals in 2015, and currently is not on track to meet future goals either. Since 2005, overall GHG emissions have declined just 8% as seen in Figure 1 (Char, Hawkins and Sullivan, 2021)

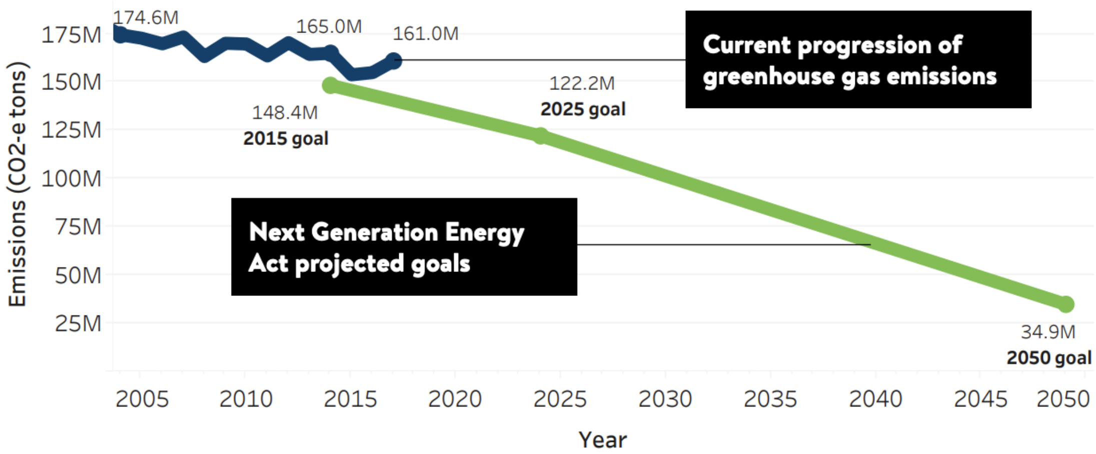

Figure 1: Minnesota's greenhouse gas emissions (millions tons CO2-e), 2005- 2018 compared to 2015, 2025 and 2050 goals of the Next Generation Energy Act

Post-pandemic Increase in the number of trips and congestion on roads boosts fuel consumption. On a global scale, the CO2 emissions from increased fuel combustion leads to an increase in greenhouse gas (GHC) emissions.(Sources of Greenhouse Gas Emissions, no date) In 2016, accounting for approximately 24% of total GHG emissions in the state, on-road transportation became the largest source of GHG emissions in Minnesota. To date, Minnesota mainly relied on federal standards for fuel efficiency to achieve GHG emission reductions in the transportation sector. "Even with mass adoption of electric cars, Minneapolis will need to reduce automobile passenger miles by 38% to reach our goal of reducing greenhouse gas emissions by 80% by 2050."(*Minneapolis Transportation Action Plan*, 2020)

Due to federal standards for fuel efficiency and GHG emissions, from 2005 to 2016, a modest reduction of 8% was observed in transportation emission. This reduction was credited to federal fuel efficiency standards and people’s habits of driving less during the recession. However, reductions have leveled off since 2016. Annual transportation emissions began to increase again in 2015 and 2016 as vehicle miles traveled increased and people purchased more trucks and SUVs. Preliminary data suggests that transportation GHG emissions have continued to increase since 2016. Figure 2 depicts Minnesota's Emissions by Sector 2005-2016 (*Pathways to decarbonizing transportation in Minnesota*, 2019)

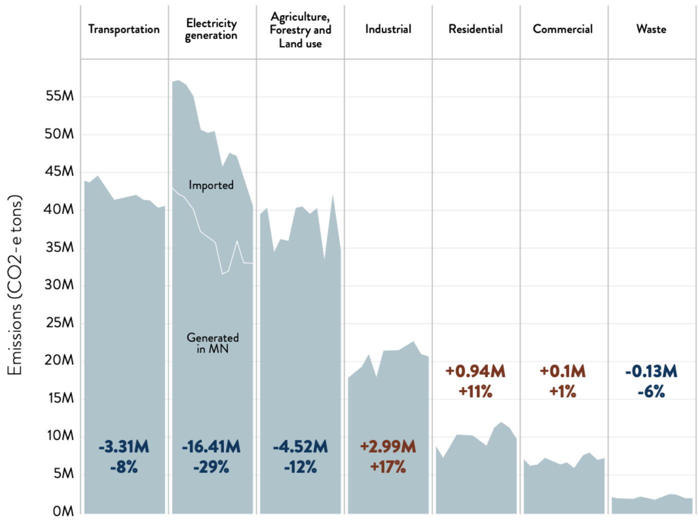

Figure 2: Minnesota Emissions by Sector 2005-2016

Considering the severe levels of Minnesota's GHG emissions from the transportation sector, and given the government’s goals of decarbonizing Minnesota, there is a grave and urgent need to control and minimize traffic jams in Minnesota. Consumer trends of owning larger vehicles and driving them for many miles contributes highly to the increase in GHG emissions. As we can control how and how often we move around, personal choices have a great impact on emissions. More than 70% of transportation GHG emissions in Minnesota are from light-duty passenger cars and trucks (including SUVs), medium-duty trucks, and heavy-duty trucks. Along with buses, motorcycles, and mobile air conditioning, these sources are considered “surface transportation” or “on-road transportation” and are displayed in Figure 3. (Pathways to decarbonizing transportation in Minnesota, 2019)

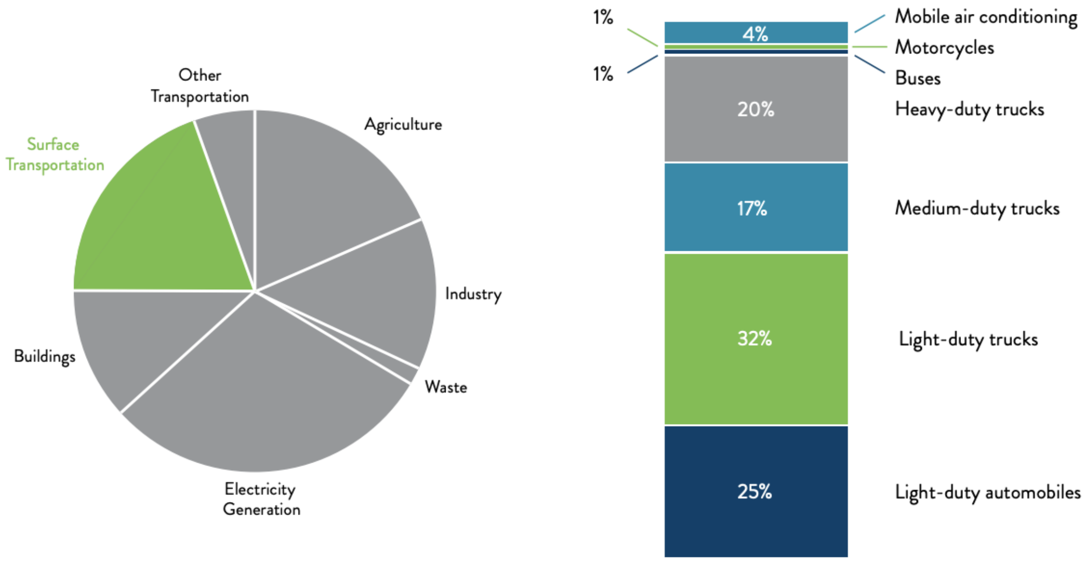

Figure 3: Minnesota emissions profile

Alleviating on-road transportation is highly dependent on user choices and will only be feasible if users are actually incentivized to contribute to reducing GHG emissions. The Minnesota Department of Transportation made a survey to gather public feedback on opinions on the co-benefits of decarbonizing transportation. Participants suggested that it was “Very Important” (64%) or “Important” (22%) that environmental justice shapes action to reduce transportation GHG emissions. Research suggested that the public was actually aware of the implications of the increase in GHG emissions and it shows potential that they will be eager in contributing to reducing GHG emissions from surface transportation. Figure 4 displays the public feedback gathered on the matter. (*Pathways to decarbonizing transportation in Minnesota*, 2019)

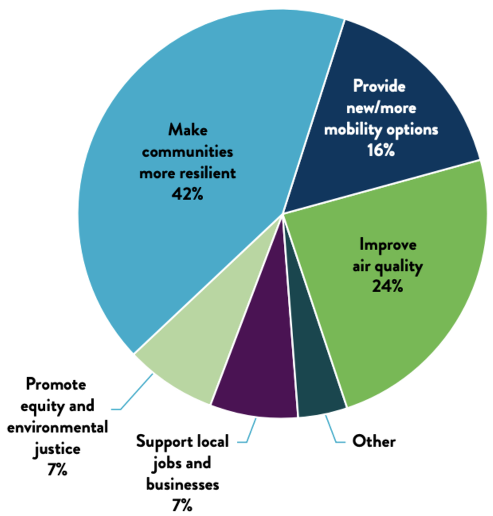

Figure 4: co-benefits from reducing transportation carbon pollution

Indeed, we see that the public sees value and motive in decarbonizing transportation. Reducing the number of vehicles on the road is the public citizen’s choice. The project objective is to make sure they rely on accurate traffic forecasts and plan which routes they should take and when to contribute to this cause.

Project Objective

The project focuses on predicting and modeling future Interstate 94 Westbound traffic volumes based on prior records and attributes such as temperature, holidays and weather features that might impact the traffic volumes.

First, the information in the dataset will be explored to understand the traffic flow on the interstate with respect to date and time. After revising and preparing the dataset to its final version, certain relationships or insightful trends between attributes will be revealed through implementing data visualizations. After exploring data visualization techniques to understand certain patterns, regression models will be implemented to predict future traffic volumes.

Forecasting traffic flow accurately contributes to numerous factors such as alleviating traffic congestion, reducing carbon emissions, helping drivers make better, more informed travel decisions and improving traffic operations efficiency. Given the transportation sector is currently the largest GHG emitter in Minnesota, and yet reduction plans have leveled off since 2016, this poses a substantial environmentalist problem for all citizens. The end-goal of the project is to use regression analysis to model and predict volumes of future road traffic and take action in managing it in advance to minimize traffic jams and generate optimal routes between two major states of Minnesota; Minneapolis and St. Paul .

Target audience

A low-carbon transportation system of the future must have strong connections between transportation stakeholders, environmental groups and also local citizen contribution. (Pathways to decarbonizing transportation in Minnesota, 2019) Specifically, attempting to estimate the number of vehicles on roads, or number of people using a transportation facility (public transit) is crucial for 3 types of target users. The target audience of the app can be listed as:

- **Local citizens**
  As emphasized throughout the project, local citizens of Minnesota have an enormous impact on the interstate traffic volume as they decide when they will go out in traffic and which routes they take.

- **Local authorities** (i.e. Minnesota Pollution Control Agency, Minnesota Department of Transportation)
  Many cities have implemented Intelligent Transportation Systems (ITS) to support traffic control and planning of the city's transportation network. ITS generates forecasts from current traffic information to improve transportation efficiency and safety by notifying users of current road conditions and adjusting road infrastructure.(Sampson et al., 2019)

- **Logistics companies** (transportation, home service, delivery …) need to accurately plan their future activities and operations and create the most effective routes. The planning and hence performance of these organizations rely highly on accurate forecasts of road and traffic conditions in order to avoid congestion and potential road infrastructure.
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Figure 5 is aimed to display the user persona of one of the target audience users of the app, local citizens.

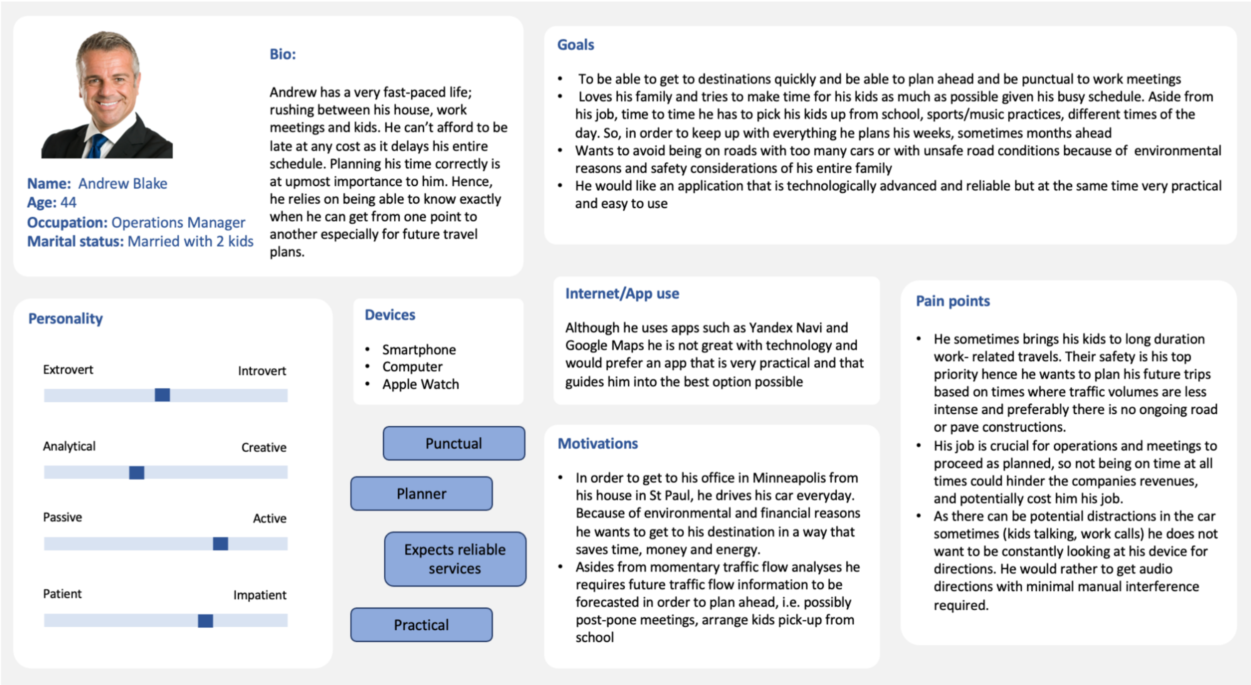

Figure 5: User persona of one of the target audiences (local citizen)

Data science questions

The ultimate goal of the project is to reduce vehicle emissions, alleviate traffic jams and congestion between Minneaplois and St Paul. This objective requires both government and civil contribution, and predicting future traffic volumes based on prior traffic information holds paramount importance for everyone. Questions we might be seeking to explore from the data include:

- What is the distribution of traffic volume over the years? How did traffic volume change over time; are there any seasonal, annual patterns or trends?
- Which factors have the most effect on traffic volume (most reliable predictors)?
- Which hours of the day yield the highest traffic volume?
- What is the effect of special days (holidays) on traffic volume?
- What is the effect of weather features on traffic volume? Which weather yields the highest traffic volume?
- Are there any outliers that skew the distributions? Does the data have complete records?
- Are the correlations between attributes intuitive?

References

Char, F., Hawkins, A. and Sullivan, D. (2021) *Greenhouse gas emissions inventory 2005-2018*. Minnesota Pollution Control Agency. Available at: https://www.pca.state.mn.us/ (Accessed: November 3, 2022).

Minneapolis Transportation Action Plan (2020) *City of Minneapolis Transportation Action Plan*. Available at: https://go.minneapolismn.gov/goals-strategies/climate (Accessed: November 12, 2022).

Pathways to decarbonizing transportation in Minnesota (2019). Office of Sustainability and Public Health & Minnesota Department of Transportation. Available at: https://www.leg.mn.gov/docs/2019/other/190966.pdf (Accessed: October 28, 2022).

Sampson, E. *et al.* (2019) *Intelligent Transport Systems (ITS) and SUMPs – making smarter integrated mobility plans and policie* . ERTICO. Available at: https://www.eltis.org/sites/default/files/the_role_of_intelligent_transport_systems_its_in_sumps.pdf (Accessed: October 29, 2022).

Sources of Greenhouse Gas Emissions (no date) *EPA* . Environmental Protection Agency. Available at: https://www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions (Accessed: November 2, 2022).