Vehicle Ownership and Use in the Vermont Travel Model

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Introduction

Many Vermont policies enacted or being considered are intended to affect vehicle ownership patterns and the composition of the state's privately-owned passenger-vehicle fleet, including Feebates, EV purchase incentives, Advanced Clean Cars (ACC) II and MileageSmart. To allow the state's travel demand model ("the Model") to be responsive to these and other federal policies, we developed a vehicle-ownership module that enables the Model to forecast vehicle ownership and use. The new module enhances the state's ability to track policy implications, highlight ownership trends of different vehicle types, and provide fuel-use and greenhouse-gas (GHG) emissions' forecasts.

Methodology

The research team linked Vermont vehicle registration data from 2011 and 2021 to EPA/DOE vehicle performance data and NHTSA manufacturer information data.

Model years from the linked data for 2011 and 2021 demonstrate the affects of the 2008 economic recession and the 2020 pandemic (Figure 1). Ownership and MPGe across the 10-year span reveals important trends. In Table 1, vehicle classes shown in orange have decreased in popularity while those shown in green have increased.

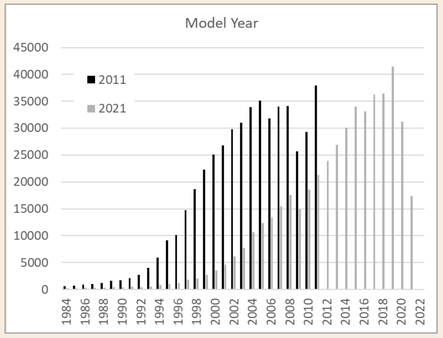


Figure 1. Histogram of Model Years from the 2011 and 2021 linked data

We then used a self-organizing map (SOM) to classify Vermont's 2011 and 2021 vehicle fleets into 9 efficiency classes. An SOM is an unsupervised machine learning technique used to produce a low-dimensional representation of a higher-dimensional data set while preserving the topological structure. After considering classifications from other policy sources like ACC II and the prevalence of certain vehicle types in Vermont, the 9 SOM classes were reduced to a 7-class system. The final set of vehicle classes align the SOM classification with other policy classifications (Table 2 and Figure 2).

Results

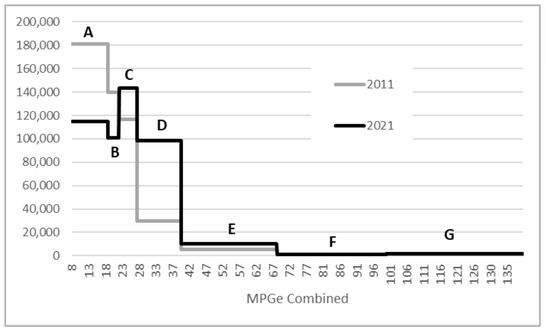
Table 1. Ownership and MPGe across the 10-year span from 2011 to 2021

	Counts			Avg. MPGe Combined		
EPA Vehicle Class	2011	2021	Change	2011	2021	Change
Compact Cars	76,468	48,732	-36%	24.6	28.0	14%
Large Cars	20,947	10,625	-49%	20.3	24.5	21%
Midsize Cars	58,477	54,612	-7%	24.0	30.9	29%
Midsize Station Wagons	13,682	3,459	-75%	20.8	24.2	17%
Large Station Wagons	4,740	216	-95%	21.3	20.9	-2%
Minivans	19,622	12,105	-38%	18.7	20.2	8%
Small Pickup Trucks	8,225	20,477	149%	18.4	19.6	6%
Small Station Wagons	13,875	17,260	24%	24.8	29.4	19%
Special Purpose Vehicles*	16,549	23,517	42%	16.0	18.0	12%
Standard Pickup Trucks	93,524	65,797	-30%	15.3	16.6	8%
Sport Utility Vehicles	111,203	193,155	74%	19.1	23.5	23%
Subcompact Cars	23,213	10,472	-55%	25.2	25.5	1%
Vans	6,951	5,114	-26%	14.4	14.3	-1%

*Mix of minivans, SUVs, and pickup trucks

Table 2. Final set of vehicle classes

Class	MPGe Comb. Range	2011			2021		
		Avg MPGe	No.	Most common	Avg MPGe	No.	Most common
A	00.0 – 18.5	15.8	181,278	2003 Ford F-150	16.5	114,902	2010 Chevy Silverado
B	18.5 – 21.7	20.3	139,526	2004 Subaru Forester	20.1	101,059	2012 Toyota Tacoma
C	21.7 – 27.1	23.8	116,410	2005 Toyota RAV4	24.3	143,240	2014 Subaru Outback
D	27.1 – 40.0	29.2	29,958	2006 Honda Civic	29.8	98,166	2016 Honda CR-V
E	40.0 – 68.0	46.0	5,379	2008 Toyota Prius	47.2	10,279	2014 Toyota Prius
F	68.0 – 99.9	78.0	1	2002 Toyota RAV4	84.4	1,004	2018 Toyota Prius
G	100.0 +		0		115.7	1,649	2018 Nissan Leaf



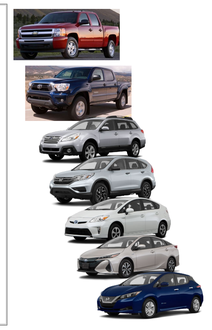


Figure 2. Distribution of vehicle classes by MPGe for 2011 and 2021

Conclusions

Forecasting change in the Vermont fleet requires realistic default rates of growth and change, along with the ability to alter these past trends to forecast scenarios. Scenario modeling is needed for forecasts that are consistent with policy goals. Past trends in vehicle ownership in Vermont are typified by (1) shifts to more efficient vehicle classes and (2) efficiency improvements within classes (Table 3).

Table 3. Efficiency improvements within classes in Vermont

Class	Avg. MPGe		Forecast Annual Growth Rates	
	2011	2021	Default	Aggressive C.A.F.E.
Truck	8.6	9.0	0.005	
A	15.8	16.5	0.004	0.025
B	20.3	20.1	0.000	0.003 – 0.019
C	23.8	24.3	0.002	0.003 – 0.019
D	29.2	29.8	0.002	0.005 – 0.017
E	46.0	46.6	0.001	0.005 – 0.017
F	78.0	90.5	0.015	0.017
G	99.6	115.7	0.015	0.017

This Model is the first of its kind in Vermont with the capability of forecasting the effects of Vermont policies like EV purchase incentives and federal policies like C.A.F.E. standards. This capability will allow VTrans and its stakeholders to make more accurate forecasts of fuel use and GHG emissions from mobile sources in Vermont (Table 4).

Table 4. CO_2 emissions improvements by class

Class	Avg CO_2 emissions (grams/mile)	
	2011	2021
A	571.8	548.0
B	440.5	446.8
C	377.0	369.4
D	303.4	300.0
E	193.9	188.2
F	0.0	57.7
G	0.0	0.0

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References

USEPA: Population and Activity of On-road Vehicles in MOVES2014; SmartWay Carrier Performance Ranking.

NHTSA: Passenger Automobile Average Fuel Economy Standards. 49 CFR Part 531, 2023

VTDEC: Chapter 40: Vermont Low Emission Vehicle and Zero Emission Vehicle Rules. Air Quality and Climate Division of the Vermont's Department of Environmental Conservation, effective December 16, 2022.