Update of Model Improvement

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Introduction

- **Update of Recent Model Improvement**
- Last SCAG ABM Update Report
  - Sep. 2023 MTF
  - 2019 Base Year Validation / Peer Review
  - The model was used in analyzing SCAG 2024 Draft RTP/SCS
- Analysis of Draft RTP Model Operation:
  - Identified Areas for Model Improvement

Areas Identified for Model Improvement

- Analysis of Draft RTP Model Output Revealed:
  - Insufficient Growth of Rail Usage Relative to Infrastructure Expansion
  - Model Sensitivity to Bike Lane Needs Improvement

- Review of Model Input for Forecast Years:
  - Changes in Future Transit Route Patterns from LA Metro's NextGen
  - Update of Auto Operating Cost - Data and Methodology

Outline

- Mode Choice Model Enhancement
  - Transit
  - Biking
- Model Input/Parameter Update
  - Auto Operating Cost
- Future Increase on Electric Vehicles

MODE CHOICE MODEL IMPROVEMENT – TRANSIT

Enhancement of Transit Mode Choice Model

1. Redefinition of Transit Stop Density Variables
   - To reflect NextGen's reduced route patterns compared to the 2019 base year
2. Creation of a New Variable for Commuter Rail Accessibility
   - Measured by both service frequency and distance to commuter rail stations
3. Enhancement of Model Sensitivity to All Day Service Expansion
4. Validation of Base Year Transit Boarding
   - Line level for rail
   - Agency level for bus

Improvement Results – Boarding Sensitivity

- Improved Sensitivity of Mode Choice Model to Transit Modes.
  - By Transit
  - By Bus and Rail
- Elasticity of Transit Boarding to Increased Transit Service Frequency
  - Increased to 0.61 from 0.25
  - Falls within the range found in recent literature (0.3 to 1.0)

Improvement Results – Base Year Validation

Further validate base year transit boarding in more detail:

- Line level for rail, and
- Agency level for bus

Final Validation Report

Transit Group	Model	Actual	Ratio	%RMSE	R-Squared
Rail Boarding	**376,592**	**372,495**	**1.01**		
Metrolink - VC/PS	4,359	3,639	1.20	19.02	0.978
Metrolink - OC/PS	10,463	8,699	1.20		
Metrolink - AV	10,792	5,729	1.88		
Metrolink - SB	7,503	9,736	0.77		
Metrolink - RV	3,533	4,251	0.83		
Metrolink - IEOC	4,724	4,501	1.05		
Metrolink - 91L	5,163	2,934	1.76		
LA Metro - Red/Purple	142,596	133,413	1.07		
LA Metro - Blue	71,763	64,648	1.11		
LA Metro - Expo	43,707	58,002	0.75		
LA Metro - Green	30,492	29,287	1.04		
LA Metro - Gold	41,496	47,656	0.87		
Bus Boarding	**1,511,654**	**1,479,367**	**1.02**		
LA Metro	946,001	909,600	1.04	11.11	0.998
OCTA	106,140	121,600	0.87		
Long Beach	54,893	64,500	0.85		
LADOT	56,161	60,295	0.93		
Santa Monica	59,097	52,500	1.13		
Foothill	62,096	40,100	1.55		
Omnitrans	39,835	35,600	1.12		
Riverside Transit Agency	27,267	26,200	1.04		
Montebello	21,893	20,600	1.06		
Culver City	20,025	15,500	1.29		
All Other Agencies	118,246	132,873	0.89		
Total Boarding	**1,888,246**	**1,851,862**	**1.02**		

Draft Validation report

Table 16-9: Year 2019 Daily Transit Boardings - Model vs. Actual Counts

Transit Mode	Model Estimated Boardings	Actual Boardings	Ratio
Commuter Rail	48,165	39,489	1.22
Urban Rail	346,169	333,006	1.04
All LA Metro Bus *	932,642	878,862	1.06
Other Bus **	511,831	560,382	0.91
Total Boarding	**1,838,807**	**1,811,739**	**1.01**

** All LA Metro Bus: Local bus, Rapid bus, Express bus and BRT operated by LA Metro*
*** Other Bus: Local bus, Rapid bus and Express bus operated by other transit carriers in SCAG region*

Improvement Results – Future Year Forecast

- The improved model demonstrates reasonable consistency with the growth in terms of supply (revenue miles) and demand (boarding).
- Increase in boarding and transit share is more aligned with last (2020) RTP

	2024 Draft RTP		2020 RTP		2024 Final RTP	
	2019	2050 PL	2016	2045 PL	2019 BY	2050 PL
Ratio (Boarding/Rev. Miles)						
Commuter Rail	**3.3**	**2.4**	**3.5**	**3.4**	**3.2**	**4.2**
Local Rail	**14.1**	**11.8**	**15.2**	**20.8**	**13.4**	**14.4**
Local Bus	2.6	4.0	3.3	5.3	2.7	5.4
All Transit	2.9	4.0	3.1	5.0	3.0	5.3
Transit Boarding	1,838,806	3,377,998	1,900,992	4,164,880	1,888,246	4,437,972
change		***1,539,192***		***2,263,888***		***2,549,726***
Transit Share	2.3%	3.2%	3.0%	4.5%	2.3%	4.1%
change		**0.9%**		**1.6%**		**1.7%**

MODE CHOICE MODEL IMPROVEMENT - BIKE

Enhancing Model Sensitivity to Bike Lane Infrastructure

- SCAG identified the need to improve model sensitivity to bike lane infrastructure, especially for school trip purpose.
- With the majority of school children carpooling with household adults to travel to/from school, improved bike infrastructure near schools is expected to encourage a shift from carpooling to biking.
- The improved model is now better equipped to account for this interaction, enabling more accurate measurement of the benefits of planning strategies such as Safe Routes to School.

Improvement Results – Model Share for School Purpose

- The improved model yields more reasonable results regarding walk/bike share to the bike lane expansion. The interaction between carpool and walk/bike modes is more accurately represented in the model.

Mode Share (School)	Base	Base + 50%	Change
Before Improvement			
Drive Alone	2.01%	1.97%	-0.04%
Carpool	71.20%	71.06%	**-0.14%**
Transit	6.64%	6.39%	-0.25%
Walk / Bike	20.15%	20.58%	**0.43%**
After Improvement			
Drive Alone	2.02%	2.27%	0.25%
Carpool	70.16%	66.98%	**-3.18%**
Transit	6.43%	6.76%	0.33%
Walk / Bike	21.39%	23.98%	**2.59%**

MODEL PARAMETER UPDATE – AUTO OPERATING COST

Auto Operating Cost (AOC) Overview

- A crucial model parameter used to calculate travel expenses by vehicles, typically expressed in cents or dollars per mile.
- AOC calculation consists of three components: fuel price, fuel efficiency, and non-fuel costs, including maintenance, repair and tire expenses.
- AOC Formula: $AOC = \left(\frac{Fuel\ Price}{Fuel\ Efficiency}\right) + Non\,Fuel\ Cost$
- Recent Data Update:
  - Fuel Price: Utilizing newly released 2023 data
  - Fuel Efficiency: Updated data sourced from CARB’s EMFAC 2021 model

VMT Rebound Effect by Auto Operating Cost

- An increase in AOC leads to higher driving costs, resulting in a decrease in VMT.
- This VMT rebound effect, measured by elasticity through model sensitivity tests, reflects travel behavior responses to changes in model input (AOC) or policy instruments.
- To demonstrate a model's ability to reasonably reflect travel behavior or VMT rebound in response to changes in AOC, its elasticity to AOC should align with the range of elasticities identified in literatures.

VMT Elasticity: Fuel Price vs. Fuel Efficiency

- Fuel price and fuel efficiency are the two main components to calculate AOC.
- VMT elasticity varies significantly with respect to fuel price and to fuel efficiency, as observed in literature reviews:
  - The average VMT elasticity to fuel price is approximately -0.08, with a range between -0.075 and -0.11. This indicates that a 10% increase in fuel price results in roughly a 0.8 percent decrease in VMT.
  - In contrast, VMT elasticity to fuel efficiency is identified as between 0 and 0.01. This implies that fuel efficiency have minimal impact on vehicle use and VMT.

VMT Elasticity: Fuel Price vs. Fuel Efficiency

- In a travel demand model, fuel price and fuel efficiency are not directly used as separate inputs. Instead, the computed AOC, which integrates both fuel price (as the numerator) and fuel efficiency (as the denominator), serves as a model input.
- Model sensitivity tests reveal that VMT elasticity shows similar magnitude concerning fuel price (-0.08) and fuel efficiency (+0.06).
- However, based on the literature review, the VMT rebound effect is expected to be more pronounced in response to changes in fuel price compared to fuel efficiency.
- The higher VMT rebound to fuel efficiency in the model will lead to under-estimation of AOC, and thus over-estimate VMT, which affects the accuracy of model results for planning analysis.

Collaborative Adjustment Procedure for AOC Calculation

- To address inconsistencies in VMT rebound related to fuel efficiency between model outcomes and observed travel behavior, transportation modelers from the 4 MPOs (SCAG, SANDAG, SACOG, and MTC) collaborated to develop an adjustment procedure for calculating AOC model inputs.
- Through the adjustment procedure applied to fuel efficiency, VMT elasticity to fuel efficiency reaches 0.01. This indicates that the adjustment has effectively aligned the model results with expected patterns, improving its accuracy in representing real-world travel dynamics.

Fuel Efficiency Adjustment

Adjust fuel efficiency of gasoline and diesel with below equation.

$$FE_{(ya)} = FE_{(b)} / \{\{[FE_{(y)}/FE_{(b)}] -1\} * (VMT_{eFE} / VMT_{eFP}) + 1\}$$

Where:

$FE_{(ya)}$: adjusted fuel efficiency for year y
$FE_{(b)}$: fuel efficiency for base year b
$FE_{(y)}$: fuel efficiency for year y
VMT_{eFE}: VMT elasticity to fuel efficiency, VMT_{eFE} = 0~0.01 (literature)
VMT_{eFP}: VMT elasticity to fuel efficiency, VMT_{eFP} = -0.08 (model sensitivity test)

** The adjustment procedure is detailed in the Appendix of the Model Validation Report.*

AOC Update

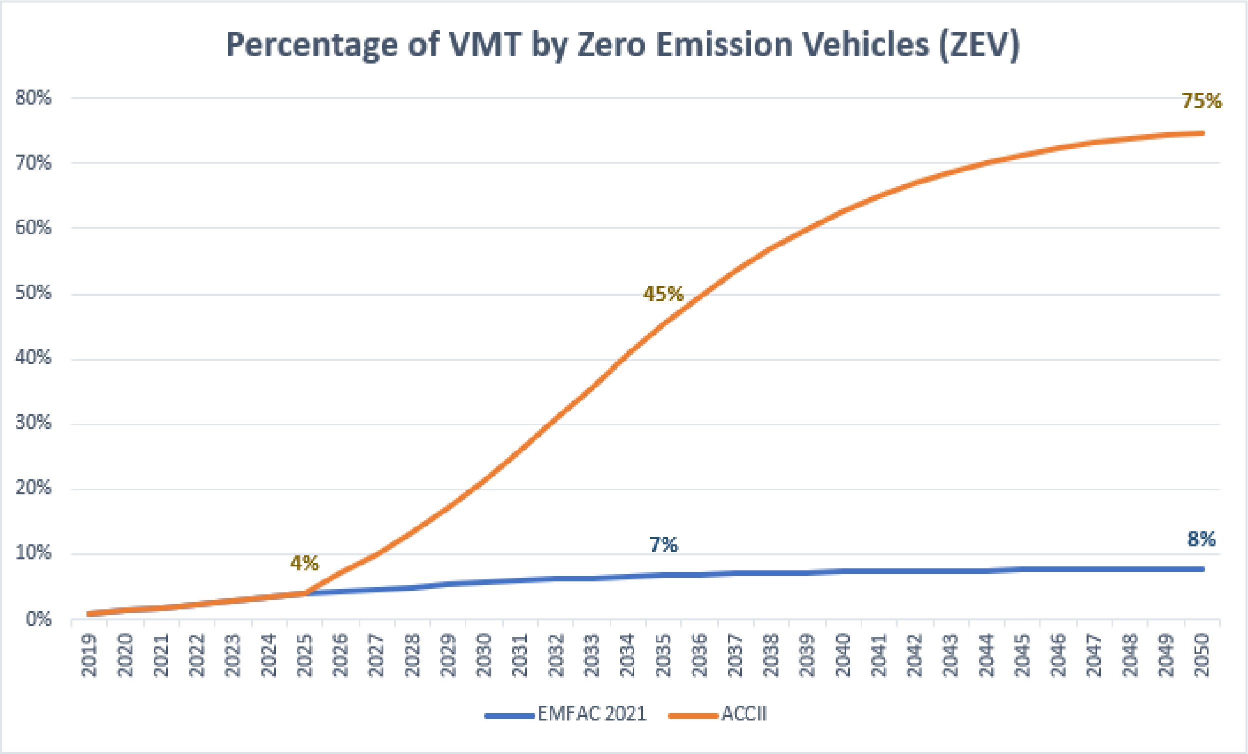
- The table below summarizes the changes in AOC resulting from the update in fuel price and fuel efficiency data.
- Given the minor differences observed, the revised AOC has only a moderate impact on model output. VMT is expected to increase by less than 1%.

Model Improvement	2019	2050 BL	%
Before (Draft RTP)	18.81	25.63	36%
After (Final RTP)	20.36	26.92	32%

FUTURE INCREASE ON EV USAGE

Future Vehicle Usage

- California's Advanced Clean Cars II (ACC2) Rule mandates phasing out new sales of gasoline-powered vehicles by 2035.
- Projected % of Total VMT by ZEVs is expected to surge to 75% by 2050, up from the 8% assumed in the current EMFAC 2021.
- Conversely, travel by gasoline vehicles is projected to decline from 96% today to 5% by 2050.



Calculation of Composite AOC

- Due to the significant increase in EV usage in the future, a composite AOC is calculated by below procedure:
    1. Calculate AOC for vehicles by each fuel type separately.
    2. Compute the Composite AOC as the average AOC weighted by the usage for vehicles by fuel type (% VMT).

$$AOC = \sum_i (AOC_i \times \%VMT_i)$$

Where:
AOC_i: AOC of vehicles by fuel type i
$\%VMT_i$: Percentage of total VMT of vehicles by fuel type i
i *: Vehicle by fuel types: gasoline (including PHEV), diesel, electricity (ZEV, PHEV)*

2050 Composite AOC

AOC for Vehicles by Fuel Type

Year	Gas	Diesel	PhEV (gas)	PhEV (ev)	EV/Hydrogen
2019	20.5	19.1	17.2	10.9	11.3
2050	26.9	25.6	23.7	16.9	16.7

% VMT for Vehicles by Fuel Type (ACC2)

Year	Gas	Diesel	PhEV (gas)	PhEV (ev)	EV/Hydrogen
2019	97%	0%	1%	1%	1%
2050	5%	0%	2%	6%	87%

Year	Comp. AOC
2019	20.4
2050	17.3

-15%

2019 Composite AOC = 20.5*97% + 19.1*0% + 17.2*1% + 10.9*1% + 11.3*1% = 20.4

2050 Composite AOC = 26.9*5% + 25.6*0% + 23.7*2% + 16.9*6% + 16.7*87% = 17.3

Controversial Results of Composite Methodology

- Analysis from 2019 to 2050 indicates a significant increase in AOC for each fuel types. However, the calculated composite AOC shows a 15% reduction over the same period.
- This difference suggests a possible overestimation of VMT with the current methodology.

AOC for Vehicles by Fuel Type

Year	Gas	Diesel	PhEV (gas)	PhEV (ev)	EV/Hydrogen	Comp. AOC
2019	20.5	19.1	17.2	10.9	11.3	20.4
2050	26.9	25.6	23.7	16.9	16.7	17.3
% Chg	**31%**	**34%**	**38%**	**55%**	**48%**	**-15%**

Suggested Revision Methodology

1. Calculate % AOC Growth from the base year to the target year for vehicles by each fuel type separately.

2. Compute the Composite % AOC Growth as the average % AOC Growth weighted by the usage for vehicles by fuel type (% VMT).

3. Composite AOC is calculated by multiplying the Composite % AOC Growth by the base year AOC.

2050 Composite AOC (Suggested Revision)

% AOC Growth for Vehicles by Fuel Type

Year	Gas	Diesel	PhEV (gas)	PhEV (ev)	EV/Hydrogen
2019	20.5	19.1	17.2	10.9	11.3
2050	26.9	25.6	23.7	16.9	16.7
% Chg	**31%**	**34%**	**38%**	**55%**	**48%**

% VMT for Vehicles by Fuel Type (ACC2)

Year	Gas	Diesel	PhEV (gas)	PhEV (ev)	EV/Hydrogen
2019	97%	0%	1%	1%	1%
2050	**5%**	**0%**	**2%**	**6%**	**87%**

Year	% AOC Gr.	Comp. AOC
2019		**20.4**
2050	**47.3%**	**30.0**

Composite % AOC Growth from 2019-2050 = 31%*5% + 34%*0% + 38%*2% + 55%*6% + 48%*87% = 47.3

2050 Composite AOC = 2019 AOC * % AOC Growth from 2019-2050 = 20.4* (1+47.3%) = 30.0

Implications of New EV Information on AOC Calculation

1. Data suggests significant EV growth even pre-ACC2, with EMFAC 2021 projecting % of VMT by EVs to rise from 0.9% in 2019 to 7.7% by 2050.

2. The AOC for EVs is notably lower than for ICVs, averaging approximately 40% less than gasoline-fueled vehicles.

3. Recent studies from UC Davis (2021), MIT (2023), and SCAG's review of 2022 NHTS data indicate no significant differences in vehicle usage or annual VMT between EVs and ICVs. This suggests that despite lower AOCs, those transitioning from ICVs to EVs maintain similar travel patterns and VMT.

Given these findings, the increase in EV usage is likely to influence the composite AOC, resulting in a decrease in composite AOCs.

Final Summary

Recent model improvements include:

1. Mode Choice Model enhancements for transit and biking, resulting in increased transit and bike use and a reduction in VMT.
2. Updated data for Auto Operating Cost, leading to a moderate reduction in AOC and consequently an increase in VMT.
3. Overall, the 2050 VMT and other model outputs remain consistent between the model improvements (Draft and Final RTP).

Additionally:

- The reason and method for fuel efficiency adjustment are described.
- Finally, the implications of the increase in future EV usage are presented.

THANK YOU