

# Attachment C

Updated Costs and Benefits Analysis for the  
Proposed Advanced Clean Trucks Regulation

As described in the notice, the proposed modifications (Proposed Modifications) to the Proposed Advanced Clean Trucks Regulation (Proposed ACT Regulation) are anticipated to increase the number of zero-emission vehicles (ZEVs) that medium-duty and heavy-duty manufacturers would be required to sell into California as compared to the original proposal (Original Proposal). Therefore, the costs and benefits are greater than estimated for the Original Proposal in the October 2019 Staff Report: Initial Statement of Reasons (Staff Report) developed for this rulemaking. This preliminary revised costs and benefits summary has been prepared to provide an estimate of the updated air quality, health, and climate benefits as well as an updated economic analysis under the Proposed Modifications. A final economic and fiscal assessment will be prepared for the Final Statement of Reasons (FSOR) at the close of the regulatory process, and this preliminary costs and benefits assessment is subject to change based on available information.

## **I. UPDATED EMISSIONS BENEFITS**

This chapter summarizes the potential air quality impacts in California as a result of the Original Proposal and Proposed Modifications, and includes an overview of the emission inventory methods, a description of the baseline used to estimate emission benefits of the Proposed ACT Regulation, and the resulting changes in NO<sub>x</sub>, PM<sub>2.5</sub>, and GHG emissions. The details of the emission inventory development are discussed in Attachment D.

### **A. Baseline Information**

All actions as a result of the Proposed Modifications are compared against a business as usual (BAU) baseline and the Original Proposal. The BAU Baseline is based on the California's emissions inventory and includes the effects of existing state and federal regulations while the Original Proposal models the anticipated results of the regulation described in the Staff Report.

### **B. Emission Inventory Methods**

Staff used the latest available data on population, activity and in-use emissions from medium- and heavy-duty truck fleets operating in California to estimate the BAU baseline emissions and assess the impact of proposed and alternative scenarios on both criteria and GHG emissions.

All population and mileage numbers for vehicles affected by the Proposed Modifications and Original Proposal are derived from the EMFAC2017 model. Staff created scenarios for the BAU baseline conditions, conditions under the Original Proposal, and conditions under the Proposed Modifications. Staff then produced emissions inventories for all scenarios by running the EMFAC2017 model to estimate tank-to-wheel emissions. WTW emissions were estimated using emission rates derived from the CA GREET 3.0.

NO<sub>x</sub>, PM<sub>2.5</sub>, and GHG emissions reductions are based on the tailpipe emission difference between the ICE and ZEV vehicles. PM<sub>2.5</sub> emission reductions also include a

50 percent reduction in brake wear due to the regenerative braking of ZEVs reducing brake usage. GHG emission calculations include upstream emissions associated with fuel production. The GHG benefits for this rule do not include any ZEVs which may be used to comply with the California Phase 2 GHG regulation. Only ZEVs sold in excess of the California Phase 2 GHG regulation's requirements are included in GHG calculations to avoid double-counting.

### C. Emission Inventory Results

The Proposed Modifications are expected to result in significant NO<sub>x</sub>, PM<sub>2.5</sub>, and GHG emission reductions due to replacing internal combustion powered vehicles with zero-emission technology. ZEVs produce no tailpipe emissions, reduce brake wear PM emissions, and have lower upstream emissions. Table I-1 summarizes the expected criteria emission benefits in 2031 and 2040. These emission reductions contribute to the State SIP Strategy, Climate Change Scoping Plan, and carbon neutrality goals.

**Table I-1: Expected Emission Reductions of the Proposed Modifications to the Proposed ACT Regulation**

<b>Calendar Year</b>	<b>NO<sub>x</sub> (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>	<b>WTW GHG (MMT/yr)</b>
2031	6.9	0.24	0.5
2040	27.9	0.85	2.9

Figure I-1 illustrates NO<sub>x</sub> emissions of the Proposed Modifications relative to the BAU baseline and Original Proposal. In the BAU baseline, projected NO<sub>x</sub> emissions decrease sharply until 2023. This is mainly due to the Truck and Bus regulation which requires most diesel vehicles with a GVWR above 14,000 lb. to upgrade to 2010 MY and newer engines. NO<sub>x</sub> reductions continue in the baseline mainly due to natural attrition of Class 2b-3 vehicles and vehicles not subject to the Truck and Bus regulation including solid waste collection vehicles, public and utility fleets, and alternatively fueled vehicles. Under the Proposed Modifications, emissions decline at a greater rate as ZEVs enter the fleet and displace the emissions of ICE vehicles.

**Figure I-1: Projected NOx Emissions**

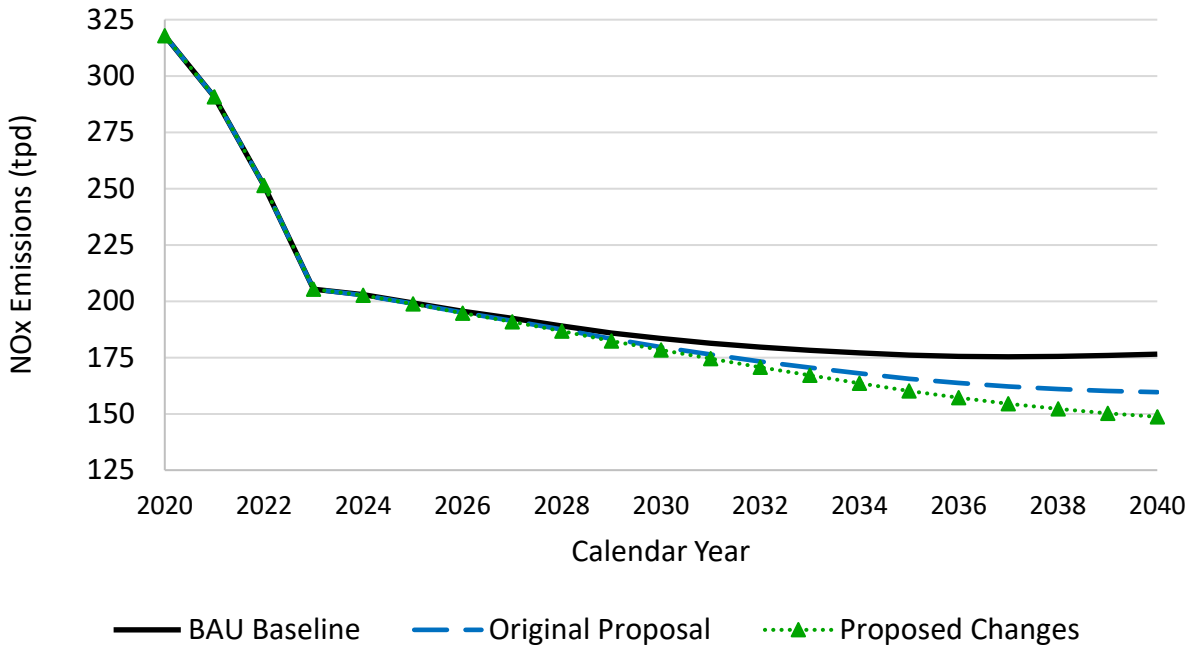


Figure I-2 illustrates PM<sub>2.5</sub> emissions of the Proposed Modifications relative to the BAU baseline and Original Proposal. Similar to NOx, PM<sub>2.5</sub> emissions decrease sharply in the BAU baseline scenario until 2023 but slowly rise afterwards. By 2023, nearly all diesel trucks with a GVWR greater than 14,000 lbs. will have diesel particulate matter filters due to the Truck and Bus Regulation. Beginning 2024, PM<sub>2.5</sub> emissions begin to increase slightly as vehicle miles travelled in EMFAC continue to grow, but the increase is partially offset from some PM<sub>2.5</sub> emissions reductions from lighter vehicles that continue to be replaced through normal attrition. Under the Proposed Modifications, emissions decline as the emission reductions associated with ZEVs cancel out the expected PM<sub>2.5</sub> increases associated with growth.

**Figure I-2: Projected PM2.5 Emissions**

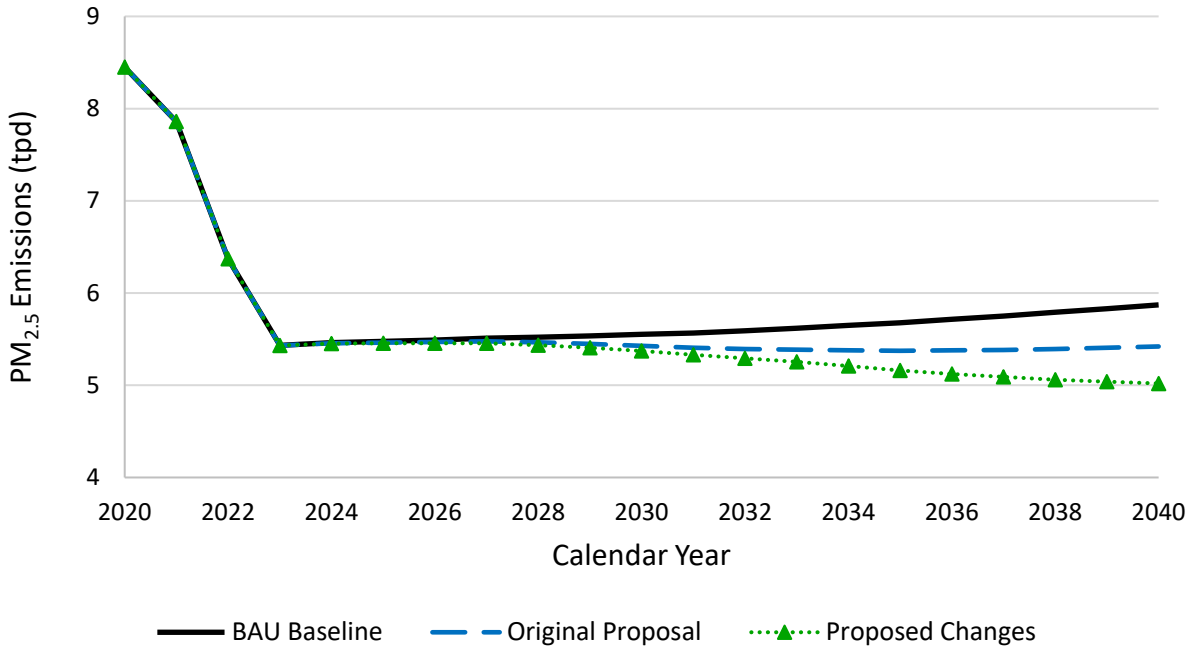
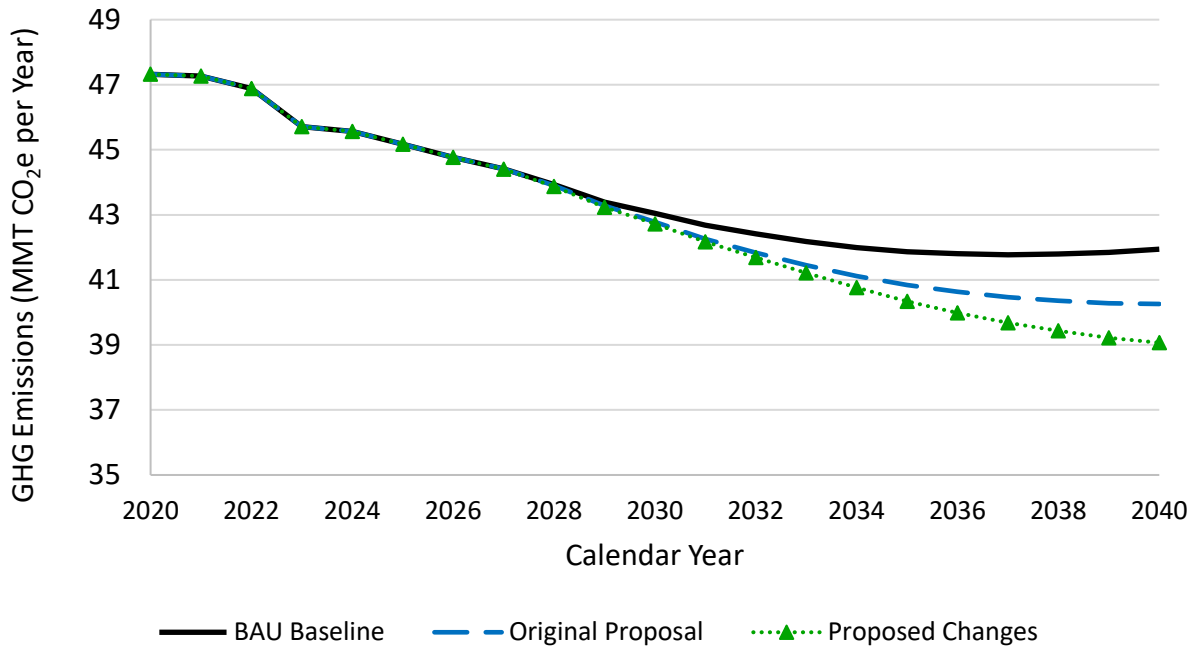


Figure I-3 illustrates the WTW GHG emissions of the Proposed Changes relative to the BAU baseline and Original Proposal. In the BAU baseline scenario, GHG emissions decline over time as the LCFS regulation decreases the carbon intensity of fuels and trucks are replaced and upgraded to more efficient models subject to the Phase 2 GHG regulations. Emissions start to level out near 2040 as vehicle miles travelled continues to increase. Under the Proposed ACT Regulation, GHG emissions decline throughout 2040 due to the lower tailpipe emissions of ZEVs compared to ICE vehicles. Note that the GHG emission benefits do not include ZEVs which may be used for Phase 2 GHG compliance. As a result, only a portion of the Class 4-8 group generate GHG benefits beyond the Phase 2 GHG regulation under the Proposed ACT Regulation.

From 2020 to 2040, the Proposed Modifications are expected to reduce GHG emissions by a cumulative 17.3 MMT CO<sub>2</sub>e. Of these reductions, 14.4 MMT CO<sub>2</sub>e are due to tank-to-wheel emission reductions, 0.5 MMT CO<sub>2</sub>e from well-to-tank emission reductions within the AB 32 boundary around California, and 2.3 MMT CO<sub>2</sub>e from well-to-tank emission reductions outside the AB 32 boundary i.e. elsewhere in the world. The amount of emission reductions within the AB 32 boundary will vary depending on whether decreases in petroleum production and refining occur within or outside California.

**Figure I-3: Projected WTW GHG Emissions**



## II. UPDATED HEALTH BENEFITS

The Proposed ACT Regulation reduces NO<sub>x</sub> and PM<sub>2.5</sub> emissions resulting in health benefits for Californians, especially those living in communities disproportionately impacted by truck and freight emissions. These health benefits will result in fewer instances of premature mortality, fewer hospital and emergency room (ER) visits, and fewer missed days at school and work. As the Proposed Modifications are anticipated to increase NO<sub>x</sub> and PM<sub>2.5</sub> emission reductions versus their Original Proposal, there is a corresponding increase in health benefits. The methodology to calculate avoided morbidity and mortality as well as valuation of these events is the same as described in the Staff Report in Chapter V.

Table II-2 shows the estimated avoided premature mortality, hospitalizations, and emergency room visits because of the Proposed Modifications for 2020 through 2040 by California air basin, relative to the baseline. Values in parenthesis represent the 95 percent confidence intervals of the central estimate. As detailed in the previous section, the Proposed ACT Regulation is estimated to reduce overall emissions of PM<sub>2.5</sub> and NO<sub>x</sub> in most years, and lead to net reduction in adverse health outcomes statewide, relative to the baseline.

The Proposed ACT Regulation may decrease the occupational exposure to air pollution of California truck operators and other employees who work around truck traffic. CARB staff cannot quantify the potential effect on occupational exposure due to lack of data on the typical occupational exposure for these types of workers.

**Table II-2: Regional and Statewide Avoided Mortality and Morbidity Incidents from 2020 to 2040 under the Proposed Modifications to the Proposed ACT Regulation \***

<b>Air Basin</b>	<b>Avoided Premature Deaths</b>	<b>Avoided Hospitalizations for Cardiovascular Illness</b>	<b>Avoided Hospitalizations for Respiratory Illness</b>	<b>Avoided ER Visits</b>
Great Basin Valleys	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Lake County	1 (1 - 1)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Lake Tahoe	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Mojave Desert	6 (5 - 8)	1 (0 - 2)	1 (0 - 2)	2 (2 - 3)
Mountain Counties	7 (5 - 8)	1 (0 - 1)	1 (0 - 1)	2 (1 - 3)
North Central Coast	4 (3 - 5)	1 (0 - 1)	1 (0 - 2)	3 (2 - 3)
North Coast	2 (1 - 2)	0 (0 - 0)	0 (0 - 0)	1 (0 - 1)
Northeast Plateau	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Sacramento Valley	40 (31 - 48)	5 (0 - 9)	6 (1 - 10)	15 (9 - 21)
Salton Sea	5 (4 - 6)	1 (0 - 1)	1 (0 - 2)	2 (1 - 3)
San Diego County	43 (34 - 53)	6 (0 - 12)	7 (2 - 13)	17 (11 - 24)
San Francisco Bay	87 (68 - 106)	14 (0 - 27)	16 (4 - 29)	47 (30 - 65)
San Joaquin Valley	118 (93 - 144)	14 (0 - 28)	17 (4 - 30)	43 (27 - 59)
South Central Coast	16 (13 - 20)	2 (0 - 5)	3 (1 - 5)	7 (4 - 9)
South Coast	614 (480 - 750)	103 (0 - 203)	124 (29 - 218)	313 (198 - 427)
Statewide	943 (738 - 1153)	148 (0 - 290)	177 (41 - 312)	453 (287 - 620)

\*Values in parenthesis represent the 95% confidence interval. Totals may not add due to rounding.

The methodology for monetizing health impacts is the same as described in the Staff Report. Statewide valuation of health benefits were calculated by multiplying the value per incident by the statewide total number of incidents for 2020-2040 as shown in Table II-3. The estimated total statewide health benefits derived from criteria emission reductions are estimated to be \$8.9 billion from 2020 to 2040.

**Table II-3: Statewide Estimated Annual Valuation from Avoided Health Outcomes**

<b>Calendar Year</b>	<b>Avoided Premature Deaths</b>	<b>Avoided Hospitalizations for Cardiovascular Illness</b>	<b>Avoided Hospitalizations for Respiratory Illness</b>	<b>Avoided ER Visits</b>	<b>Valuation (Million \$2018)</b>
2024	0	0	0	0	\$10
2025	1	0	0	1	\$23
2026	2	0	0	1	\$41
2027	4	1	1	2	\$69
2028	7	1	1	4	\$111
2029	12	2	2	6	\$166
2030	18	3	3	9	\$237
2031	25	4	4	12	\$320
2032	34	5	6	17	\$415
2033	44	7	8	21	\$519
2034	55	8	10	27	\$633
2035	67	10	12	32	\$756
2036	80	13	15	39	\$879
2037	93	15	18	45	\$1,002
2038	106	17	20	51	\$1,124
2039	119	19	23	57	\$1,243
2040	132	21	25	63	\$1,358
<b>Total Cost* (million \$2018)</b>	<b>\$8,887</b>	<b>\$8.4</b>	<b>\$8.7</b>	<b>\$0.4</b>	<b>\$8,904</b>

\*Totals may not add due to rounding

### **III. UPDATED CLIMATE BENEFITS**

The Proposed ACT Regulation accounts for GHG benefits in terms of carbon dioxide (CO<sub>2</sub>). The benefit of these GHG reductions can be estimated using the Social Cost of Carbon (SC-CO<sub>2</sub>), which provides a dollar valuation of the damages caused by one ton of carbon pollution and represents the monetary benefit today of reducing carbon emissions in the future. As the Proposed Modifications are anticipated to increase CO<sub>2</sub> emission reductions versus their Original Proposal, there is a corresponding increase in climate benefits. The methodology to calculate the social cost of carbon is the same as described in the Staff Report in Chapter V.

If all GHG reductions under the Proposed ACT Regulation are assumed to be carbon reductions, the avoided SC-CO<sub>2</sub> from 2020 to 2040 is the sum of the annual WTW GHG emissions reductions multiplied by the SC-CO<sub>2</sub> in each year. The cumulative WTW GHG emission reductions along with the estimated benefits from the Proposed ACT Regulation are shown in Table III-4. These benefits range from about \$398 million to nearly \$1.7 billion through 2040, depending on the chosen discount rate.



**Table III-4. Avoided Social Cost of CO<sub>2</sub>**

<b>Year</b>	<b>GHG emission reductions (MMT)</b>	<b>Avoided SC-CO<sub>2</sub> 5% discount rate (million 2018\$)</b>	<b>Avoided SC-CO<sub>2</sub> 3% discount rate (million 2018\$)</b>	<b>Avoided SC-CO<sub>2</sub> 2.5% discount rate (million 2018\$)</b>
2024	0.0	\$0	\$0	\$0
2025	0.0	\$0	\$0	\$0
2026	0.0	\$0	\$0	\$0
2027	0.0	\$0	\$0	\$0
2028	0.1	\$1	\$3	\$5
2029	0.2	\$3	\$10	\$14
2030	0.3	\$6	\$19	\$28
2031	0.5	\$10	\$31	\$45
2032	0.7	\$15	\$45	\$65
2033	1.0	\$20	\$62	\$89
2034	1.2	\$27	\$81	\$115
2035	1.5	\$33	\$102	\$144
2036	1.8	\$42	\$123	\$173
2037	2.1	\$48	\$144	\$205
2038	2.4	\$57	\$166	\$234
2039	2.6	\$64	\$187	\$264
2040	2.9	\$73	\$209	\$292
<b>Total</b>	<b>17.3</b>	<b>\$398</b>	<b>\$1,182</b>	<b>\$1,675</b>

It is important to note that the SC-CO<sub>2</sub>, while intended to be a comprehensive estimate of the damage caused by carbon globally, does not represent the cumulative cost of climate change and air pollution to society. There are additional costs to society outside of the SC-CO<sub>2</sub>, including costs associated with changes in co-pollutants, the social cost of other GHGs including methane and nitrous oxide, and costs that cannot be included due to modeling and data limitations. The Intergovernmental Panel on Climate Change (IPCC) has stated that the IWG SC-CO<sub>2</sub> estimates are likely underestimated due to the omission of significant impacts that cannot be accurately monetized, including important physical, ecological, and economic impacts.

#### **IV. UPDATED ECONOMIC COSTS AND BENEFITS**

##### **A. New Assumptions that Differ from the Staff Report**

###### ZEV percentage sales requirement

In the Proposed Modifications, staff proposes to increase manufacturer ZEV sale requirements in all vehicle groups in all model years. These changes and their rationale are described in more detail in Attachment A and Attachment B. The updated ZEV sales requirements are displayed in Table IV-5.

**Table IV-5: ZEV Sales Percentage Schedule in Proposed Changes**

<b>Model Year</b>	<b>Class 2b-3*</b>	<b>Class 4-8**</b>	<b>Class 7-8 Tractor</b>
2024	5%	9%	5%
2025	7%	11%	7%
2026	10%	13%	10%
2027	15%	20%	15%
2028	20%	30%	20%
2029	25%	40%	25%
2030	30%	50%	30%
2031	35%	55%	35%
2032	40%	60%	40%
2033	45%	65%	40%
2034	50%	70%	40%
2035 and beyond	55%	75%	40%

Class 2b-3 ZEV sales to individuals

As a result of the increased requirements found in the Proposed Modifications, staff anticipates that a portion of the manufacturers' sales in the Class 2b-3 vehicle group will be to individuals rather than fleets. The assumptions staff made for Class 2b-3 vehicles in the Original Proposal's staff report are not applicable for individuals; therefore, Class 2b-3 ZEVs sold to individuals are modelled separately with modified assumptions.

The assumptions are listed below:

- Same assumptions as Staff Report
  - Accrual rates, ZEP Certification (not applicable), Phase 2 GHG compliance costs, manufacturer reporting costs, gasoline, diesel, and hydrogen cost, vehicle maintenance, maintenance bay upgrades, midlife costs, transitional costs and workforce development, registration fees, battery recycling, repurposing, and disposal
- Vehicle price
  - In the Staff Report, staff assumed that manufacturers would need to sell longer ranged vehicles for vehicle groups with more stringent requirements. For Class 2b-3 ZEVs, staff assumed manufacturers could meet the requirements of the Original Proposal without selling long-range ZEVs due to the relatively modest number of ZEVs required. In this analysis for the Proposed Modifications, staff assumes all Class 2b-3 ZEVs sold to individuals are configured as long-range (80 kWh battery), using prices as modeled in Staff Report on page IX-11. This assumption is due to the current status of the light-duty ZEV market where vehicles with 80 kWh batteries or longer are becoming commercially available for large SUVs and trucks.
- Electricity cost
  - In the Staff Report, staff assumed a deployment of 20 vehicles charged overnight using commercial electricity rates using 19 kW chargers. For

individuals, staff is assuming one vehicle charged overnight using residential electric vehicle rates using a 6.6 kW Level 2 charger. If multiple electricity rates were available, staff selected the option that does not require a separate meter and has the lowest electricity cost to represent a typical customer who does not have a separate meter installed. The electricity cost for Class 2b-3 vehicles using these assumptions was \$0.189/kWh, roughly \$0.02/kWh lower than the previous assumptions for Class 2b-3 ZEVs.

- Low Carbon Fuel Standard revenue
  - In the Staff Report, Class 2b-3 ZEVs earned LCFS credits as staff assumed larger fleets would build and own their own infrastructure and earn the credits. Residential customers are not eligible to receive LCFS credits as any credits generated by the ZEV would be awarded to the utility provider. This analysis models no LCFS credit revenue for Class 2b-3 ZEVs sold to individuals. Some very small businesses would be in this group if the vehicles are charged at a residence.
- Fueling infrastructure and maintenance
  - In the Staff Report, staff assumed a Class 2b-3 ZEVs would need a 19.2 kW Level 2 charger costing \$5,000, infrastructure upgrades costing \$20,000, and on-going charger maintenance of \$500 per charger per year. These costs reflect a scenario where a larger fleet needs to install multiply chargers in a parking lot and will need to trench through asphalt, upgrade switchgear and lay conduit. Individuals or very small businesses would be expected to install Level 2 chargers in or near their garage with lower costs. In the Updated Proposal, staff assumes a Class 2b-3 ZEV sold to an individual will spend \$500 for charger, \$1,250 for installation, and \$5 per year for maintenance (Avista, 2019). These costs are not amortized.

#### Updated assumptions for vehicle groups

In the Staff Report for the Original Proposal, staff assumed that manufacturers would need to sell vehicles with higher range capabilities for vehicle groups with more stringent requirements. In the Proposed Modifications, the stringency across the rule has increased, so staff is modelling that manufacturers will sell long ranged vehicles as a greater proportion of their sales.

- Class 2b-3
  - Original Proposal: All vehicles are sold as normal range
  - Updated Proposal: For individuals, all long range. For fleets, all vehicles are sold as normal range until 2027 MY. After 2027 MY, half are sold as normal range and half as long range
- Class 4-8 excluding Class 7-8 tractors
  - Original Proposal: Until 2030 MY, all vehicles are sold as normal range. After 2030 MY, half of vehicles are sold as normal range and half as long range
  - Updated Proposal: Keep same assumptions as Original Proposal

- Class 7-8 Tractors
  - Original Proposal: 90 percent of tractors are sold as battery-electric, 10 percent as fuel cell electric.
  - Updated Proposal: Keep same assumptions as Original Proposal

The updated assumptions for each vehicle group are listed in Table IV-6.

**Table IV-6: Vehicle Groups and Technologies**

<b>Vehicle Group</b>	<b>Baseline Scenario</b>	<b>Proposal Scenario</b>
Class 2b-3	Gasoline (43%) Diesel (57%)	Battery-electric 30% – Individuals – All long-range 70% – Fleets – 50% long-range after 2028
Class 4-5	Diesel	Battery-electric 50% long-range after 2030
Class 6-7	Diesel	Battery-electric 50% long-range after 2030
Class 8	Diesel	Battery-electric 50% long-range after 2030
Class 7-8 Tractor	Diesel	90% – Battery-electric 10% – Fuel Cell Electric

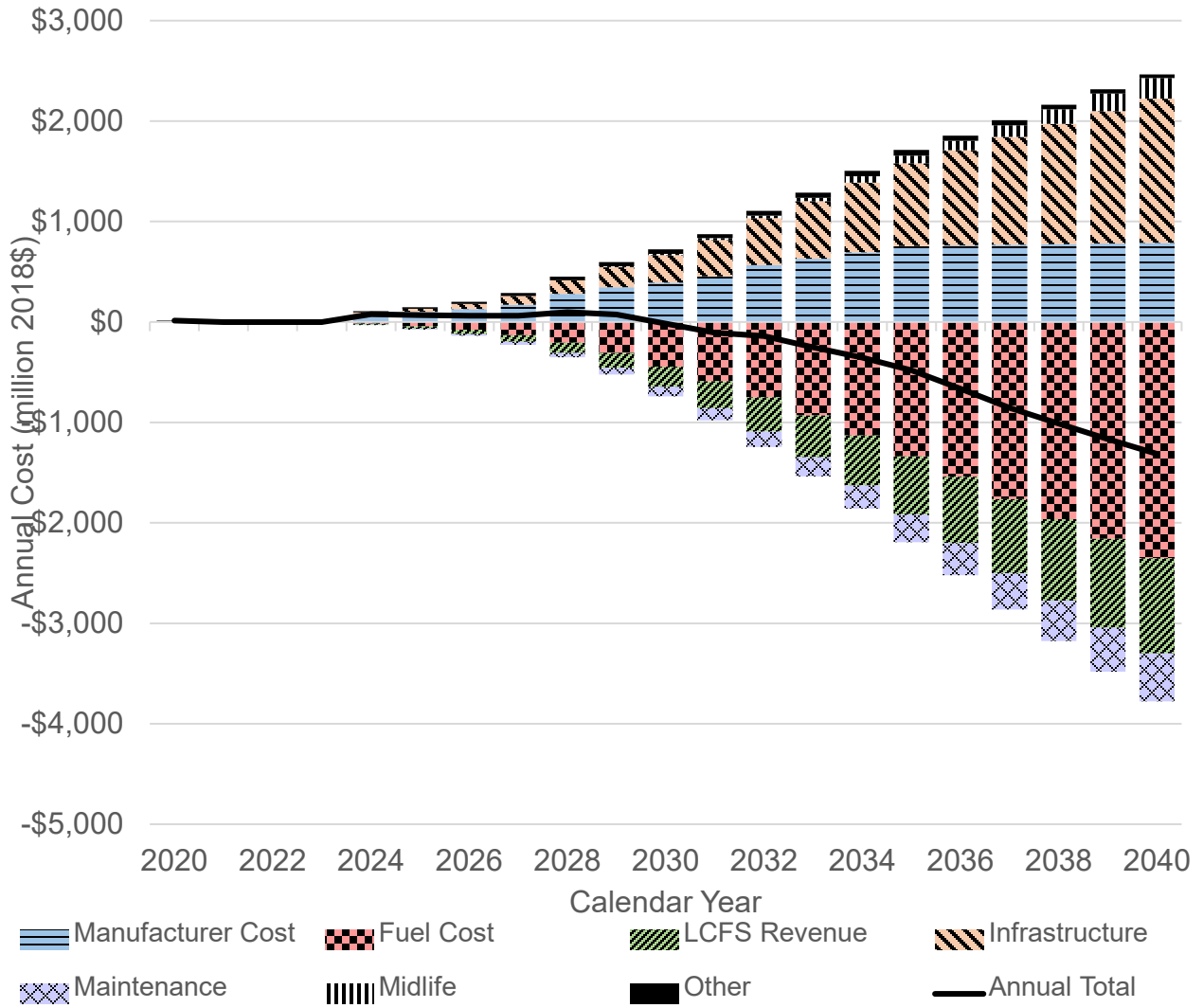
**B. Updated Costs Breakdown**

The Proposed Modifications would increase the number of ZEVs sold in California relative to the BAU baseline as well as the Original Proposal. These ZEVs have higher upfront capital costs for the vehicle and infrastructure investments, but lower operating costs over time resulting in lower overall costs for truck transportation in California. The cost to truck transportation in California assuming all vehicle manufacturer costs and 10 percent of the Phase 2 GHG savings are passed on is -\$5.9 billion between 2020 and 2040 compared to the BAU baseline scenario. Figure IV-4 illustrates the difference in cost between the Proposed Modifications and the BAU baseline scenario using the cost categories shown in Table IV-7. The total costs by cost input are shown in Table IV-8.

**Table IV-7: Summarized Cost Items**

<b>Cost Category</b>	<b>Components</b>
Manufacturer Cost	ZEV Price, ICE Phase 2 GHG (cost avoided), ZEP Certification
Fuel Cost	Gasoline, Diesel, Electricity, Hydrogen Fuel Cost
LCFS Revenue	LCFS Revenue
Infrastructure	Charger Costs, Infrastructure Upgrades, Charger Maintenance
Maintenance	Vehicle Maintenance Costs, Maintenance Bay Upgrades
Midlife	Midlife Costs
Other	Sales Tax, Federal Excise Tax, Registration Fees, Large Entity Reporting, Transitional Costs and Workforce Development

**Figure IV-4: Total Estimated Direct Costs of Proposed Updates Relative to the BAU Baseline (million 2018\$)**



**Table IV-8: Total Estimated Direct Incremental Costs of the Proposed Updates Relative to the BAU Baseline  
(million 2018\$)**

Calendar Year	ZEV Price <sup>1</sup>	ICE Phase 2 GHG (Cost Avoided) <sup>1</sup>	ZEP Cert. <sup>1</sup>	Large Entity Reporting <sup>2</sup>	Sales & Excise Tax <sup>2</sup>	Fuel Cost <sup>2</sup>	LCFS Revenue <sup>2</sup>	Vehicle Maintenance Cost <sup>2</sup>	Maintenance Bay Upgrades <sup>2</sup>	Midlife Costs <sup>2</sup>	EVSE & Infrastructure Installation & Maintenance <sup>2</sup>	Transitional Costs & Workforce Development <sup>2</sup>	Registration Fees <sup>2</sup>	Total Cost*
2020	\$0	\$0	\$0	\$15	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$15
2021	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2022	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2023	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0	\$0
2024	\$104	-\$22	\$0.18	\$0	\$11	-\$17	-\$11	-\$5	\$1	\$0	\$13	\$3	\$0	\$76
2025	\$128	-\$27	\$0.04	\$0	\$14	-\$43	-\$25	-\$12	\$3	\$0	\$30	\$3	\$0	\$69
2026	\$161	-\$34	\$0.04	\$0	\$17	-\$78	-\$43	-\$22	\$5	\$0	\$53	\$4	-\$1	\$63
2027	\$228	-\$56	\$0.04	\$0	\$24	-\$131	-\$68	-\$36	\$8	\$0	\$87	\$6	-\$2	\$62
2028	\$296	-\$17	\$0.04	\$0	\$31	-\$206	-\$104	-\$56	\$13	\$0	\$136	\$7	-\$3	\$98
2029	\$369	-\$23	\$0.04	\$0	\$39	-\$308	-\$149	-\$82	\$17	\$8	\$199	\$9	-\$6	\$74
2030	\$418	-\$28	\$0.04	\$0	\$44	-\$444	-\$204	-\$114	\$23	\$11	\$276	\$10	-\$8	-\$16
2031	\$485	-\$32	\$0.04	\$0	\$51	-\$590	-\$269	-\$150	\$29	\$16	\$365	\$0	-\$11	-\$106
2032	\$604	-\$37	\$0.04	\$0	\$63	-\$750	-\$341	-\$189	\$35	\$25	\$465	\$0	-\$15	-\$139
2033	\$669	-\$40	\$0.04	\$0	\$69	-\$931	-\$417	-\$232	\$41	\$34	\$575	\$0	-\$18	-\$251
2034	\$738	-\$44	\$0.04	\$0	\$75	-\$1,130	-\$497	-\$278	\$47	\$62	\$694	\$0	-\$21	-\$354
2035	\$804	-\$48	\$0.04	\$0	\$81	-\$1,337	-\$581	-\$326	\$52	\$76	\$822	\$0	-\$25	-\$480
2036	\$811	-\$48	\$0.04	\$0	\$82	-\$1,541	-\$662	-\$373	\$55	\$91	\$948	\$0	-\$29	-\$664
2037	\$817	-\$48	\$0.04	\$0	\$82	-\$1,764	-\$739	-\$417	\$58	\$117	\$1,073	\$0	-\$33	-\$855
2038	\$823	-\$49	\$0.04	\$0	\$83	-\$1,964	-\$812	-\$459	\$59	\$146	\$1,197	\$0	-\$38	-\$1,013
2039	\$829	-\$49	\$0.04	\$0	\$84	-\$2,160	-\$882	-\$499	\$60	\$175	\$1,318	\$0	-\$42	-\$1,165
2040	\$836	-\$49	\$0.04	\$0	\$84	-\$2,353	-\$948	-\$536	\$59	\$203	\$1,438	\$0	-\$47	-\$1,313
<b>Total*</b>	<b>\$9,121</b>	<b>-\$651</b>	<b>\$1</b>	<b>\$15</b>	<b>\$934</b>	<b>\$15,747</b>	<b>-\$6,750</b>	<b>-\$3,784</b>	<b>\$565</b>	<b>\$964</b>	<b>\$9,690</b>	<b>\$42</b>	<b>-\$298</b>	<b>-\$5,899</b>

\*Note: Totals may differ due to rounding

1 – These cost items are costs to manufacturers

2 – These cost items are costs to California businesses

## C. Fiscal Impact to Local and State Governments

The following sections summarize the anticipated fiscal impacts to local and state governments as a result of the Proposed Updates to the Proposed ACT Regulation. The description and methodology for calculating each cost element is the same as the Staff Report.

### 1. Fiscal Impact on Local Government

Table IV-9 shows the estimated fiscal cost to local governments due to the Proposed ACT Regulation relative to baseline conditions. The fiscal impact to local government is estimated to be -\$0.6 million over the first three years of the regulation and \$78 million over the regulatory lifetime. This positive value reflects that local governments will see a slight increase in revenue over the regulatory timeframe due to increased sales tax and utility user tax revenue.

**Table IV-9: Estimated Fiscal Impacts to Local Government (million 2018\$)**

Model Year	Large Entity Reporting	Utility User Tax Revenue	Local Gasoline and Diesel Fuel Taxes	Local Sales Tax	Local Government Fleet Cost Pass-Through	Fiscal Impact*
2020	-\$0.6	\$0	\$0	\$0	\$0	-\$0.6
2021	\$0	\$0	\$0	\$0	\$0	\$0
2022	\$0	\$0	\$0	\$0	\$0	\$0
2023	\$0	\$0	\$0	\$0	\$0	\$0
2024	\$0	\$1	-\$1	\$5	-\$2	\$2
2025	\$0	\$1	-\$3	\$6	-\$2	\$2
2026	\$0	\$2	-\$5	\$7	-\$2	\$3
2027	\$0	\$3	-\$8	\$10	-\$2	\$4
2028	\$0	\$5	-\$12	\$13	-\$3	\$4
2029	\$0	\$8	-\$18	\$17	-\$2	\$4
2030	\$0	\$11	-\$26	\$19	\$0	\$5
2031	\$0	\$14	-\$34	\$22	\$3	\$5
2032	\$0	\$18	-\$44	\$27	\$4	\$6
2033	\$0	\$22	-\$54	\$30	\$7	\$6
2034	\$0	\$27	-\$65	\$34	\$10	\$6
2035	\$0	\$31	-\$76	\$37	\$14	\$5
2036	\$0	\$35	-\$87	\$37	\$19	\$4
2037	\$0	\$39	-\$99	\$37	\$25	\$2
2038	\$0	\$43	-\$110	\$37	\$29	\$0
2039	\$0	\$47	-\$120	\$38	\$34	-\$2
2040	\$0	\$50	-\$129	\$38	\$38	-\$4
<b>Total*</b>	<b>-\$0.6</b>	<b>\$358</b>	<b>-\$890</b>	<b>\$414</b>	<b>\$171</b>	<b>\$53</b>

\*Note: Totals may differ due to rounding

## 2. Fiscal Impact on State Government

Table IV-10 shows the estimated fiscal impacts to the state government due to the Proposed ACT Regulation relative to baseline conditions. The fiscal impact to state government is estimated to be -\$1.4 million over the first three years of the regulation and -\$3.8 billion over the regulatory lifetime. This large negative value mainly represents the decreased fuel tax revenue for the state government over the regulatory timeframe.

**Table IV-10: Estimated Fiscal Impacts on State Government (million 2018\$)**

Model Year	CARB Staffing and Resources	State Gasoline and Diesel Fuel Taxes	Energy Resources Fee	Registration Fee	State Sales Taxes	State Fleet Cost Pass-Through	Fiscal Impact*
2020	-\$0.6	\$0	\$0	\$0	\$0	\$0	-\$0.6
2021	-\$0.4	\$0	\$0	\$0	\$0	\$0	-\$0.4
2022	-\$0.4	\$0	\$0	\$0	\$0	\$0	-\$0.4
2023	-\$0.4	\$0	\$0	\$0	\$0	\$0	-\$0.4
2024	-\$0.4	-\$5	\$0	\$0	\$4	-\$2	-\$3
2025	-\$0.4	-\$12	\$0	\$0	\$5	-\$1	-\$9
2026	-\$0.4	-\$20	\$0	-\$1	\$6	-\$1	-\$16
2027	-\$0.4	-\$33	\$0	-\$2	\$9	-\$1	-\$27
2028	-\$0.4	-\$52	\$0	-\$3	\$12	-\$2	-\$45
2029	-\$0.4	-\$76	\$0	-\$6	\$15	-\$2	-\$68
2030	-\$0.4	-\$106	\$1	-\$8	\$16	\$0	-\$98
2031	-\$0.4	-\$140	\$1	-\$11	\$19	\$2	-\$130
2032	-\$0.4	-\$178	\$1	-\$15	\$24	\$3	-\$165
2033	-\$0.4	-\$218	\$1	-\$18	\$26	\$5	-\$204
2034	-\$0.4	-\$262	\$1	-\$21	\$29	\$7	-\$246
2035	-\$0.4	-\$307	\$1	-\$25	\$32	\$10	-\$290
2036	-\$0.4	-\$351	\$2	-\$29	\$32	\$14	-\$333
2037	-\$0.4	-\$395	\$2	-\$33	\$32	\$18	-\$377
2038	-\$0.4	-\$435	\$2	-\$38	\$32	\$21	-\$418
2039	-\$0.4	-\$474	\$2	-\$42	\$33	\$24	-\$457
2040	-\$0.4	-\$510	\$2	-\$47	\$33	\$28	-\$494
<b>Total*</b>	<b>-\$8</b>	<b>-\$3,575</b>	<b>\$17</b>	<b>-\$298</b>	<b>\$359</b>	<b>\$124</b>	<b>-\$3,381</b>

\*Note: Totals may differ due to rounding

### D. Macroeconomic Impacts

Regional Economic Models, Inc. (REMI) Policy Insight Plus Version 2.2.8 is used to estimate the macroeconomic impacts of the Proposed Modifications on the California economy. REMI is a structural economic forecasting and policy analysis model that integrates input-output, computable general equilibrium, econometric and economic geography methodologies. More details on the methodology can be found in the original SRIA submitted to Department of Finance in Appendix C-1 of the Staff Report.



## 1. Summary and Agency Interpretation of Results

The results of the macroeconomic analysis of the Proposed Modifications are summarized in Table IV-11. As analyzed here, CARB estimates the Proposed Modifications are unlikely to have a significant impact on the California economy. Overall, the change in the growth of jobs, State GDP, and output is projected to not exceed 0.03 percent of the baseline. The Proposed Modifications results in increased growth in the truck transportation industry in California as fuel savings and LCFS credit generation from the use of ZEVs grow over time. The fuel savings for the truck transportation industry represent decreased demand for gasoline and diesel from the industry, implying a decrease in growth for the industry. This analysis also shows the negative impact estimated for state and local government output and employment due to tax revenue decreases, without any offsetting revenues.

**Table IV-11: Summary of Macroeconomic Impacts of Proposed ACT Regulation**

<b>Macroeconomic Output</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>	<b>2035</b>	<b>2040</b>
<b>GSP - % Change</b>	0.00%	0.00%	0.01%	0.02%	0.01%
<b>GSP - Change (2018M\$)</b>	1	131	469	603	282
<b>Personal Income - % Change</b>	0.00%	0.00%	0.02%	0.03%	0.04%
<b>Personal Income - Change (2018M\$)</b>	-30	84	489	1,064	1,507
<b>Employment - % Change</b>	0.00%	0.01%	0.02%	0.03%	0.03%
<b>Employment - Change in Jobs</b>	34	1,340	5,274	8,177	7,442
<b>Output - % Change</b>	0.00%	0.00%	0.01%	0.01%	0.00%
<b>Output - Change (2018M\$)</b>	-4	209	648	587	-237
<b>Private Investment - % Change</b>	0.00%	0.00%	0.00%	0.00%	0.00%
<b>Private Investment - Change (2018M\$)</b>	-8	39	196	407	485

## 2. California Employment Impacts

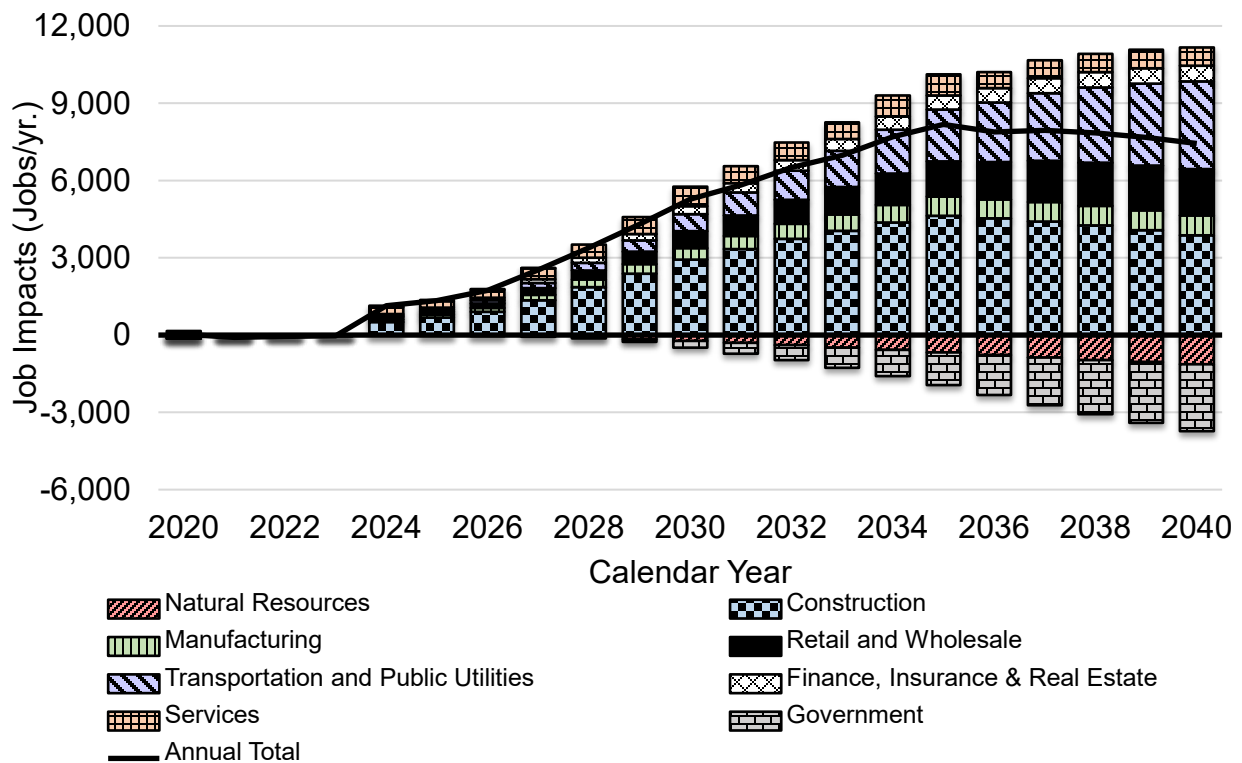
Table IV-12 presents the impact of the Proposed Modifications on total employment in California across all industries. The employment impacts represent the net change in employment, which consist of positive impacts for some industries and negative impacts for others. The employment impacts represent the net change in employment, which consist of positive impacts for some industries and negative impacts for others. The Proposed Modifications is estimated to result in a slightly positive job impact from about 2025 to 2040. These changes in employment represent less than 0.04 percent of baseline California employment.

**Table IV-12: Total California Employment Impacts**

<b>Calendar Year</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>	<b>2035</b>	<b>2040</b>
<b>California Employment</b>	24,368,647	25,267,147	26,206,546	27,105,799	27,920,649
<b>% Change</b>	0.00%	0.01%	0.02%	0.03%	0.03%
<b>Change in Total Jobs</b>	34	1,340	5,274	8,177	7,442

The total employment impacts shown above are net of changes at the industry level. The overall trend in employment changes by major sector are illustrated in Figure IV-5 and show the changes in employment by industries that are directly impacted by the Proposed ACT Regulation. As the requirements of the Proposed ACT Regulation go into effect, the industries generally realizing reductions in production cost or increases in final demand see an increase in employment growth. This includes the truck transportation, construction, and manufacturing sectors and upstream industries. The largest decrease in employment results from the public sector, which is estimated to realize a decrease in fuel and sales tax revenue and registration fees. The oil and gas extraction industry and automotive repair and maintenance industry see a decreased employment growth rate due to a reduction in final demand for their goods and services.

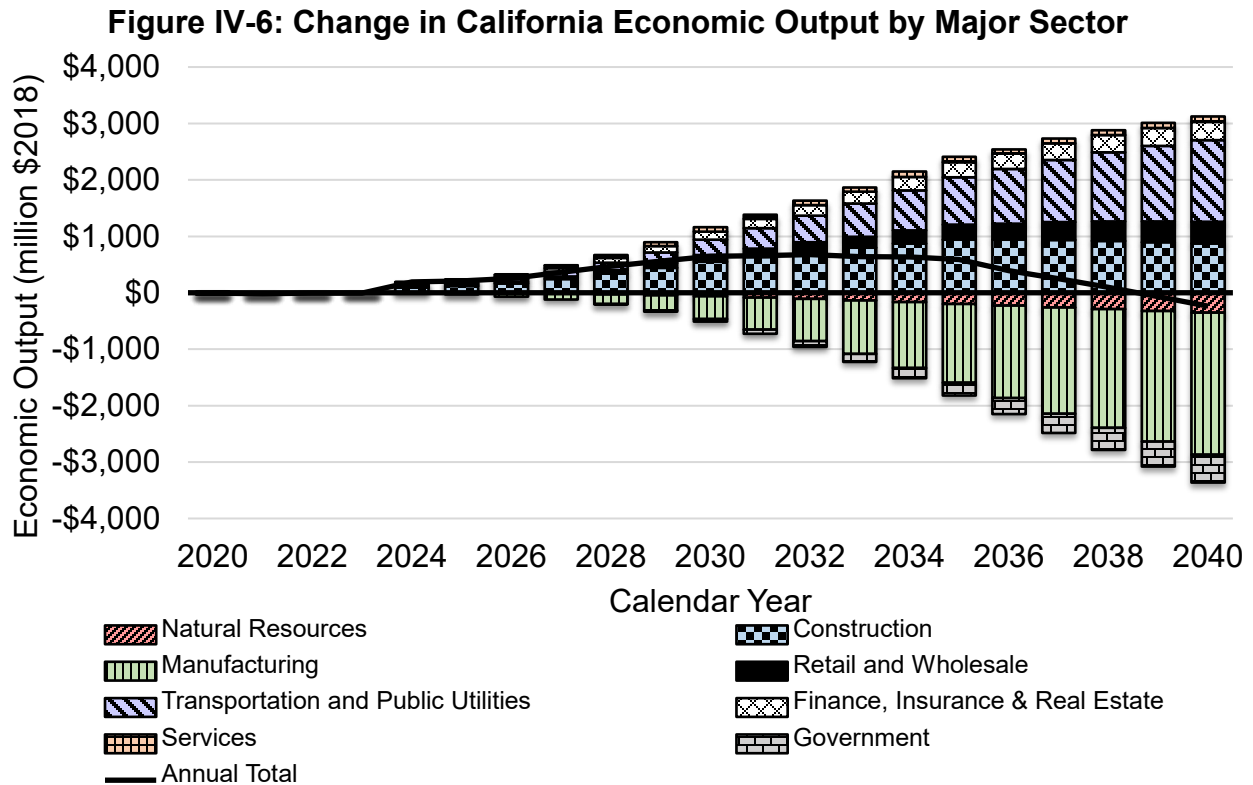
**Figure IV-5: Job Impacts by Major Sector**



### 3. California Business Impacts

Gross output is used as a measure for business impacts because as it represents an industry's sales or receipts and tracks the quantity of goods or services produced in a given time period. Output growth is the sum of output in each private industry and State and local government as it contributes to the state's gross domestic product (GDP), and is affected by production cost and demand changes. As production cost increases or demand decreases, output is expected to contract, but as production costs decline or demand increases, industry will likely experience output growth.

The results of the Proposed Modifications show an increase in output of \$648 million in 2030 and an decrease of \$237 million in 2040 as illustrated by major sector in Figure IV-6. Similar to the employment impacts, there are positive impacts on output for transportation, public utilities, and construction and negative impacts on oil and gas extraction, automotive repair and maintenance, and the public sector. The negative output impact on manufacturing is primarily driven by the petroleum and coal products manufacturing industry, which is estimated to see a relatively large decrease in demand for gasoline and diesel.



## V. SUMMARY - COSTS AND BENEFITS COMPARISON OF UPDATED PROPOSAL AND ORIGINAL PROPOSAL

To compare the Original Proposal and the Proposed Changes, staff has summarized the anticipated emissions, health, climate, and economic benefits in the tables below.

Table V-13 summarizes the projected emission benefits of the Original Proposal and the Proposed Modifications versus the baseline. The Proposed Modifications are anticipated to result in more ZEVs being deployed in California which would result in greater emissions benefits.

**Table V-13: Expected Emission Reductions of Original Proposal and Proposed Modifications**

<b>Calendar Year</b>	<b>NOx (tpd)</b>	<b>PM<sub>2.5</sub> (tpd)</b>	<b>WTW GHG (MMT/yr)</b>
Original Proposal - 2031	5.0	0.16	0.4
Original Proposal - 2040	16.9	0.46	1.7
Proposed Modifications - 2031	6.9	0.24	0.5
Proposed Modifications - 2040	27.9	0.85	2.9

Table V-14 summarizes the anticipated health benefits as a result of the Original Proposal and Proposed Modifications versus the baseline. The higher emission benefits of the Proposed Modifications are modelled to reduce mortality and morbidity incidents beyond the Original Proposal and result in a corresponding increase in the avoid health impact valuation.

**Table V-14: Statewide Estimated Avoided Mortality and Morbidity Incidents and Total Valuation from 2020 through 2040 under Original Proposal and Proposed Modifications**

<b>Calendar Year</b>	<b>Avoided Premature Deaths</b>	<b>Avoided Hospitalizations for Cardiovascular Illness</b>	<b>Avoided Hospitalizations for Respiratory Illness</b>	<b>Avoided ER Visits</b>	<b>Total</b>
Original Proposal – Number of Incidents	920	143	171	442	-
Original Proposal – Total Valuation (million \$2018)	\$5,659	\$5.3	\$5.6	\$0.2	\$5,670
Proposed Modifications – Number of Incidents	943	148	177	453	-
Proposed Modifications – Total Valuation (million \$2018)	\$8,887	\$8.4	\$8.7	\$0.4	\$8,904

Table V-15 summarizes the anticipated GHG reductions from the Original Proposal and Proposed Modifications versus the baseline. The Proposed Modifications are anticipated to require ZEV production beyond Phase 2 GHG requirements in all three vehicle groups. This combined with the increased stringency are expected to result in greater climate benefits.

**Table V-15. Estimated GHG Emissions Reductions and Avoided Social Cost of CO<sub>2</sub> for the Original Proposal and Proposed Modifications from 2020 through 2040**

	<b>GHG emission reductions (MMT)</b>	<b>Avoided SC-CO<sub>2</sub> 5% discount rate (million 2018\$)</b>	<b>Avoided SC-CO<sub>2</sub> 3% discount rate (million 2018\$)</b>	<b>Avoided SC-CO<sub>2</sub> 2.5% discount rate (million 2018\$)</b>
Original Proposal	11.2	\$256	\$762	\$1,081
Proposed Modifications	17.3	\$398	\$1,182	\$1,675

Table V-16 compares the total costs and savings for each cost component between for both the Original Proposal and the Proposed Modifications versus the BAU baseline. While ZEVs have higher incremental costs for the vehicle and infrastructure, their lower operating costs result in a net saving over time. Because the Proposed Modifications result in more ZEVs being deployed, there is a net increase in savings.

**Table V-16: Total Economic Costs and Savings for the Original Proposal and Proposed Modifications from 2020 through 2040 (million 2018\$)**

<b>Cost Component</b>	<b>Original Proposal</b>	<b>Proposed Modifications</b>
Vehicle Price	\$4,179	\$9,121
GHG Phase 2 Costs	-\$321	-\$651
ZEP Certification	\$1	\$1
Large Entity Reporting	\$15	\$15
Sales and Excise Tax	\$432	\$934
Fuel Cost	-\$9,057	-\$15,747
LCFS Revenue	-\$4,465	-\$6,750
Maintenance Cost	-\$2,292	-\$3,784
Maintenance Bay Upgrades	\$260	\$565
Midlife Costs	\$600	\$964
EVSE & Infrastructure Installation and Maintenance	\$5,987	\$9,690
Transitional Costs and Workplace Development	\$25	\$42
Registration Fees	-\$222	-\$298
<b>Total</b>	<b>-\$4,857</b>	<b>-\$5,899</b>

Table V-17 tabulates the macroeconomic impacts for both the Original Proposal and the Proposed Changes. The changes in macroeconomic impacts follow from the changes to the direct cost and benefits from the Proposed Changes. The Proposed Changes result in a slightly more positive impacts on jobs and output than the Original Proposal in 2030 and result in a slightly less positive impact on jobs and a small negative impact on output in 2040. The differences in impacts appear to result from the greater decrease in

fuel sales and fuel tax revenue from the Proposed Changes, which negatively impact the petroleum manufacturing industry and state and local governments over time.

**Table V-17: Macroeconomic Impacts of the Original Proposal and Proposed Modifications**

<b>Macroeconomic Output</b>	<b>2020</b>	<b>2025</b>	<b>2030</b>	<b>2035</b>	<b>2040</b>
<b>Original Proposal</b>					
<b>GSP - % Change</b>	0.00%	0.00%	0.01%	0.01%	0.02%
<b>GSP - Change (2018M\$)</b>	1	86	437	452	669
<b>Personal Income - % Change</b>	0.00%	0.00%	0.02%	0.03%	0.04%
<b>Personal Income - Change (2018M\$)</b>	-10	65	474	869	1,404
<b>Employment - % Change</b>	0.00%	0.00%	0.02%	0.02%	0.03%
<b>Employment - Change in Jobs</b>	8	871	4,645	5,653	8,102
<b>Output - % Change</b>	0.00%	0.00%	0.01%	0.01%	0.01%
<b>Output - Change (2018M\$)</b>	-2	136	632	492	777
<b>Private Investment - % Change</b>	0.00%	0.00%	0.00%	0.00%	0.00%
<b>Private Investment - Change (2018M\$)</b>	-3	26	177	312	428
<b>Proposed Changes</b>					
<b>GSP - % Change</b>	0.00%	0.00%	0.01%	0.02%	0.01%
<b>GSP - Change (2018M\$)</b>	1	131	469	603	282
<b>Personal Income - % Change</b>	0.00%	0.00%	0.02%	0.03%	0.04%
<b>Personal Income - Change (2018M\$)</b>	-30	84	489	1,064	1,507
<b>Employment - % Change</b>	0.00%	0.01%	0.02%	0.03%	0.03%
<b>Employment - Change in Jobs</b>	34	1,340	5,274	8,177	7,442
<b>Output - % Change</b>	0.00%	0.00%	0.01%	0.01%	0.00%
<b>Output - Change (2018M\$)</b>	-4	209	648	587	-237
<b>Private Investment - % Change</b>	0.00%	0.00%	0.00%	0.00%	0.00%
<b>Private Investment - Change (2018M\$)</b>	-8	39	196	407	485

Table V-18 tabulates the total costs and benefits for both the Original Proposal and the Proposed Modifications. The Proposed Modifications are anticipated to result in more ZEVs deployed in California. This will result in increased costs due to the higher incremental cost of ZEVs and their supporting infrastructure, and increased benefits due to lower operational costs and increased health savings. The overall benefit to cost ratio is slightly lower in the Proposed Modifications as compared to the Original Proposal. In the Original Proposal, a greater proportion of the vehicles were required in the Class 4-8 vehicle group which was projected to have higher cost reductions when switching from a diesel-powered vehicle to a ZEV. As this proportion has decreased in the Proposed Modifications, the benefit-cost ratio has declined although it still above 1.

**Table V-18: Total Benefit-Cost Ratio and Net Benefits for the Original Proposal and Proposed Modifications from 2020 through 2040 (billion 2018\$)**

<b>Scenario</b>	<b>Total Costs</b>	<b>Health Benefits</b>	<b>Cost-Saving (Benefit)</b>	<b>Tax &amp; Fee Revenue</b>	<b>Total Benefit</b>	<b>Net Benefit</b>	<b>Benefits-Cost Ratio</b>
Original Proposal	\$11.5	\$5.7	\$16.4	-\$2.3	\$19.9	\$8.4	1.7
Proposed Modifications	\$21.3	\$8.9	\$27.2	-\$3.6	\$32.5	\$11.2	1.5