Measuring the Economic, Equity, and Environmental Contributions of Transit Infrastructure

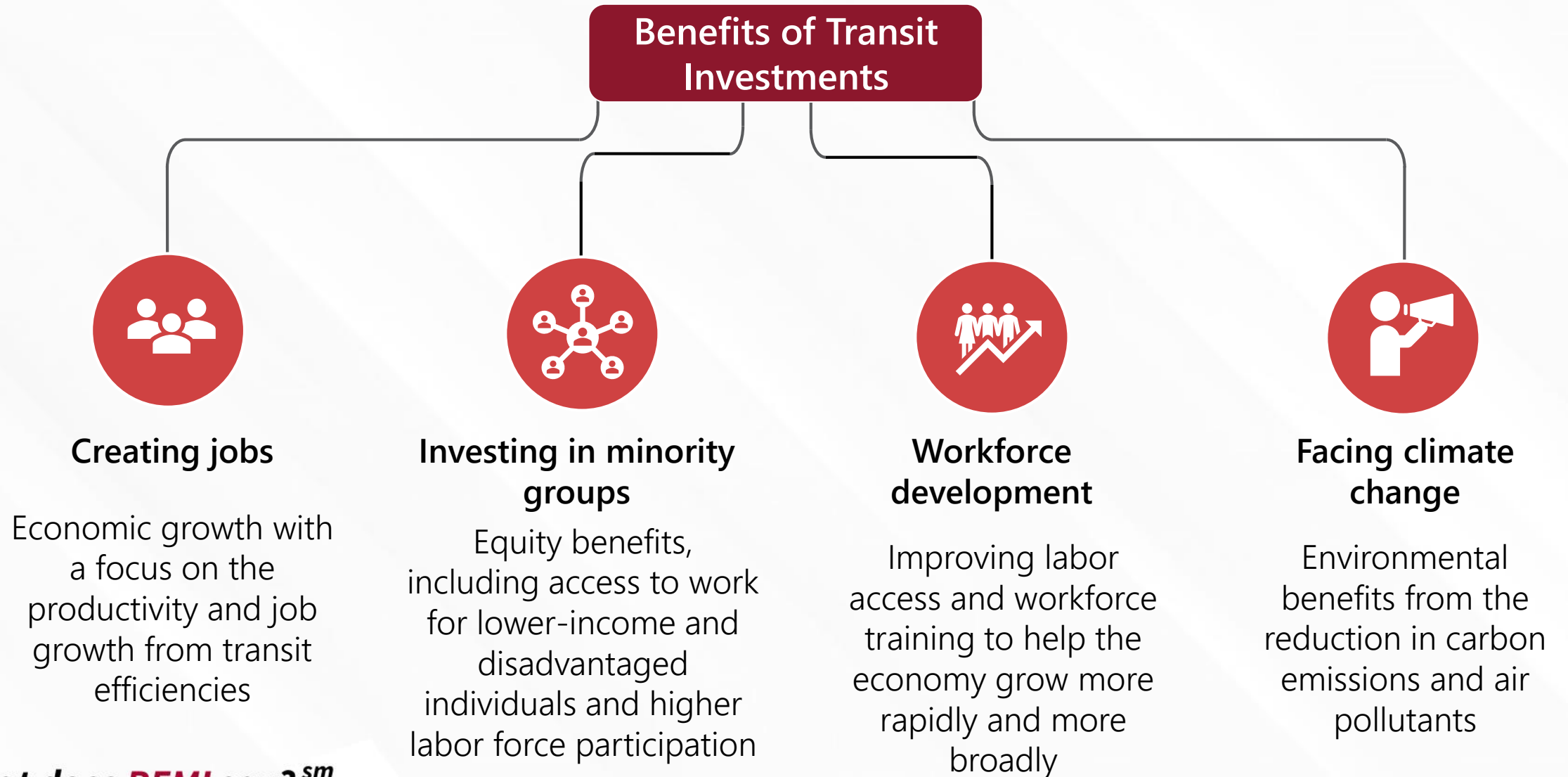Regional Economic Models, Inc.

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Project Background

Benefits of Transit Investments

Creating jobs

Economic growth with a focus on the productivity and job growth from transit efficiencies

Investing in minority groups

Equity benefits, including access to work for lower-income and disadvantaged individuals and higher labor force participation

Workforce development

Improving labor access and workforce training to help the economy grow more rapidly and more broadly

Facing climate change

Environmental benefits from the reduction in carbon emissions and air pollutants

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Use Cases (Washington, DC Metropolitan Area)

Investment 1: Bus Electrification

- Replace WMATA's bus fleet entirely with electric buses
- Expand service to account for the implementation of Bus Rapid Transit (BRT) along critical routes
- Expected to yield a substantial reduction of emissions and operating costs

Investment 2: Fixed Guideway Transit

- Complete the Purple Line, a 16-mile-long transit connection between Maryland's Montgomery and Prince George's counties
- 21 stations connecting major residential and employment centers
- Divert car trips to transit and reduce the negative externalities from car travel

Investment 3: Improved Bicycle Infrastructure

- Significant expansion of the bicycle trail and lane network
- Based on 2015 Bicycle and Pedestrian Plan for the National Capital Region
- Focus on transportation contributions, which expected to result in a shift of some of the car trips to bicycles

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Model Input and Assumptions: Bus Electrification

Assumptions	
Timeline	Analysis period: 2022-2031 Electrification completed in 5 years (2022-2026) Construction of BRT conducted concurrently
Funding	Entirely paid for with Federal funding
Initial Costs	Expended evenly through the five-year fleet replacement period

Input	Components
Manufacturing costs (2020$)	Vehicle and charging facility costs
Construction costs (2020$)	Charging facility installation and BRT construction costs
O&M cost savings (2020$)	Difference between the O&M costs of the existing fleet and the costs of operating an expanded electric bus fleet (fossil fuel annual operating costs – electric annual operating costs – fast charger O&M and fossil fuel annual fueling costs – electric annual fueling costs – BRT operating costs)
Change in energy consumption (billions of BTU)	Difference between the fuel consumption (CNG/hybrid/clean diesel/diesel/electric fuel economy x share of revenue miles) for the existing fleet and the fuel consumption for an electric bus fleet

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Model Input and Assumptions: Fixed Guideway Transit

Assumptions	
Timeline	Analysis period: 2022-2031 Construction completed in 2023 and revenue service starts in 2024 Ramp-up in ridership in the first two years of operation (one half of projected first year ridership)
Funding	Entirely paid for with Federal funding
Costs	Expended evenly through the two-year construction period

| Input	Components
Capital costs (2020$)	Vehicle acquisition, engineering and design, transportation structure, and terminal construction costs
O&M costs (2020$)	Ongoing operations and maintenance and rehabilitation costs
Vehicle trips change, VHT and VMT change	Difference between the vehicle trips, vehicle hours traveled (VHT), and vehicle miles traveled (VMT) totals with and without the Purple Line
Ridership change, PHT and PMT change	Difference between the ridership, passenger hours traveled (PHT), and passenger miles traveled (PMT) totals with and without the Purple Line

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Model Input and Assumptions: Bicycle Infrastructure

Assumptions	
Timeline	Analysis period: 2022-2031 Construction completed in 2040 (after the analysis period)
Funding	Entirely paid for with Federal funding
Costs	Construction costs expended evenly through the 2015-2040 build period, no maintenance costs

Input	Components
Construction costs (2020$)	Bicycle lane and shared use path construction costs
VMT change	Reduction in VMT from the increased bicycle network: $$\% \ change \ in \ VMT = \frac{(-1) \ \times \% \ change \ in \ bikeway \ miles \ \times \ elasticity \ \times \ existing \ bike \ mode \ share \ \times \ bike \ trip \ length}{existing \ auto \ mode \ share \ \times \ auto \ trip \ length}$$
Option value (2020$)	Transportation diversity value (halved) applied to the VMT reduction
User benefits (2020$)	Willingness to pay for use of a bicycle trail applied to the number of trips shifted from automobiles to bicycles

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Models Used: REMI TranSight & REMI SEI

- This analysis customized the PI+ model to integrate the Travel Demand Module from the REMI TranSight model and the REMI Socioeconomic Indicators (SEI) module.
- The Travel Demand Module translates the key outputs generated by the transportation models into a series of cost and amenity variables, including changes in emissions, safety, travel time, and effective distance (e.g., commuting costs).
- The SEI Module can display various results, including employment and labor force participation by race and gender, jobs by education level, income by quintile, and more.
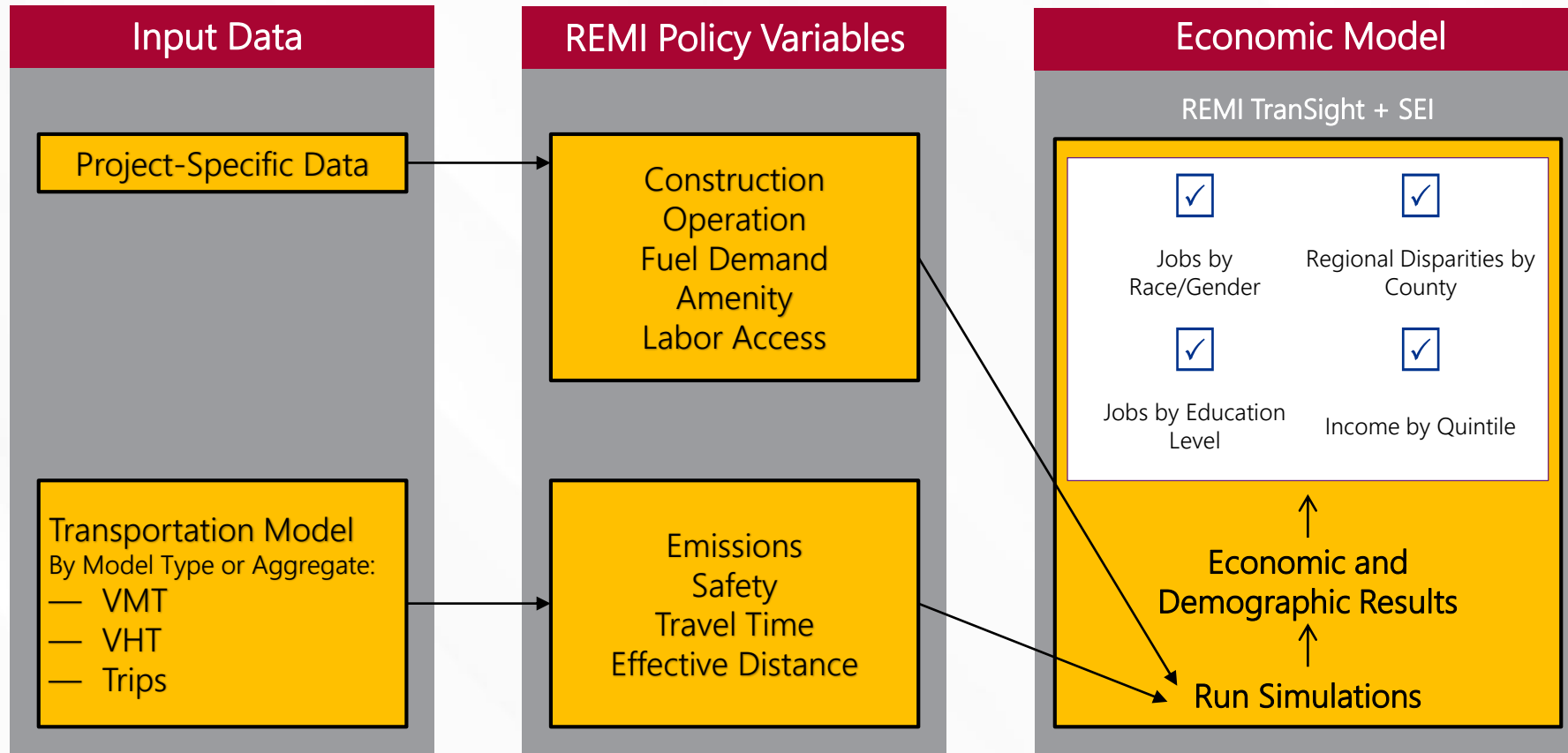
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Bus Electrification

Macroeconomic Contributions
— Job creation: 1,159 additional jobs annually on average
— GRP growth: $184 million increase in GRP in year 2031
— Labor income: A total increase of $980 million in Disposable Personal Income

Economic Benefits of Bus Electrification

Category	2031	2031 percent of region	Cumulative, 2022-2031
Change in regional total employment	1,468	0.031%	11,590
Change in Gross Regional Product ($millions, 2020)	184	0.028%	1,306
Change in Disposable Personal Income ($millions, 2020)	155	0.030%	980
Note: Cumulative total employment contributions are measured in job years instead of jobs.			

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Bus Electrification (continued)

Macroeconomic Contributions (continued)

— The maintenance and construction sectors benefit the most from infrastructure construction and bus operations
  - 611 jobs supported annually
  - Electrification is assumed to take 5 years (2022-2026). After 2026, the construction and manufacturing is complete and then the ongoing maintenance and repair work begins. This creates a bigger jump in employment in 2027

Change in Employment by Industry

Industry	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Average
All Industries	1,066	985	910	805	691	1,323	1,408	1,460	1,473	1,468	1,159
Construction	669	672	660	637	610	134	169	181	176	163	407
Repair and maintenance	7	(41)	(87)	(132)	(177)	506	500	494	488	483	204
State and local government	31	44	50	50	48	70	86	97	105	110	69
Retail trade	53	46	43	37	31	83	87	90	90	90	65
Ambulatory health care services	34	26	23	20	16	86	84	83	82	81	54
Professional, scientific, and technical services	42	38	35	30	25	44	53	60	65	68	46
Food services and drinking places	25	25	26	25	23	62	64	67	68	69	45
Real estate	29	25	25	23	19	53	57	61	62	63	42
Administrative and support services	30	25	23	19	15	47	51	54	55	56	38
Personal and laundry services	13	11	10	9	7	36	34	34	32	31	22
All other	133	114	102	87	74	202	223	239	250	254	167

Bus Electrification (continued)

Macroeconomic Contributions (continued)
— Direct and induced employment are the major components
— The project supports 485 direct jobs annually on average
— Increased labor income, improved labor access, and other dynamic economic responses create 628 more jobs on average

Direct + Indirect + Induced Effects

| Category	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	Average
Total employment	1,066	985	910	805	691	1,323	1,408	1,460	1,473	1,468	1,159
Direct employment	587	533	481	432	385	497	492	487	482	478	485
Indirect employment	66	61	56	52	47	36	35	34	34	34	46
Induced employment	413	391	372	321	259	790	881	939	956	957	628
Employment multiplier	1.82	1.85	1.89	1.86	1.80	2.66	2.86	3.00	3.05	3.07	2.39

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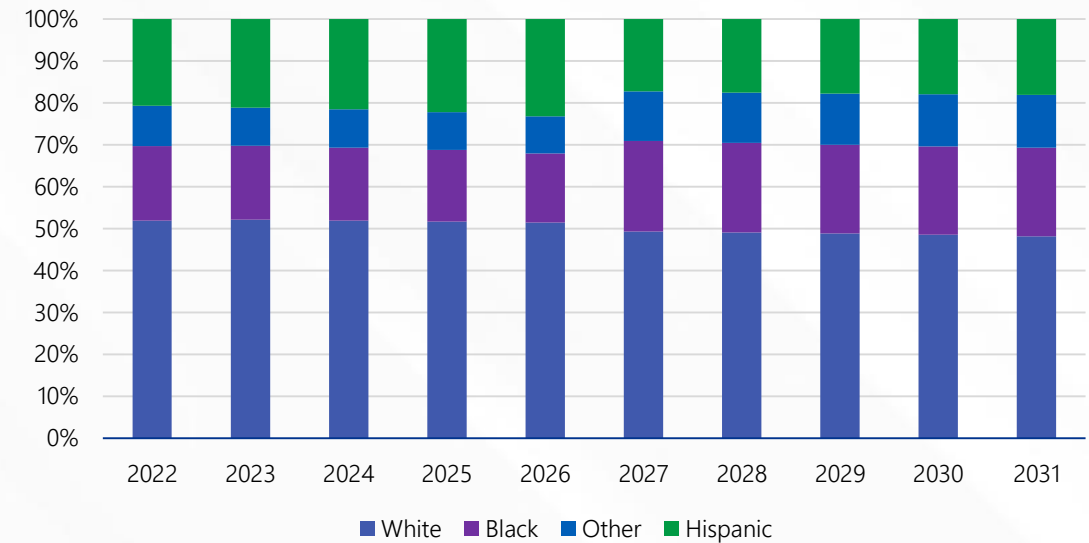
Bus Electrification (continued)

Equity Contributions

— Approximately 50% of new jobs to benefit ethnic and racial minorities

— More job opportunities for low-income and Hispanic workers

- 80% of employment gains to benefit workers in the lowest two income quintiles
- Among minority groups, Hispanics benefit from over 20% of the total jobs gained during construction phase, exceeding population share in MSA. During the operation phase, Black workers are expected to have the largest gains in employment among minority groups, accounting for approximately 21% of all new jobs

Employment by Income Quintiles

Legend: Lowest 20%, Second 20%, Middle 20%, Fourth 20%, Highest 20%
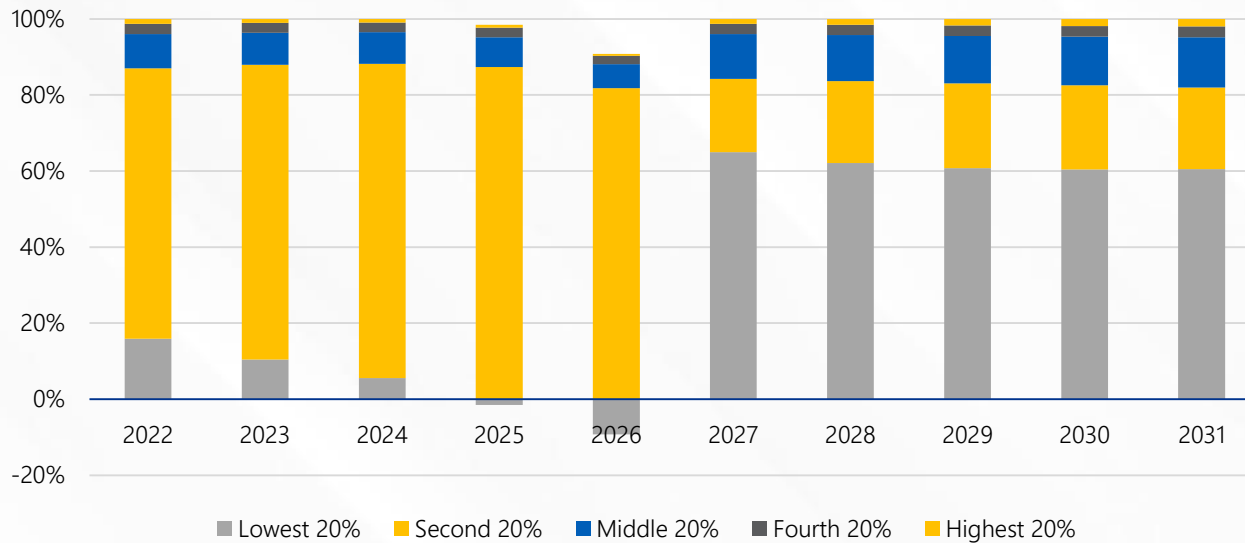
Employment by Race/Ethnicity

Legend: White, Black, Other, Hispanic

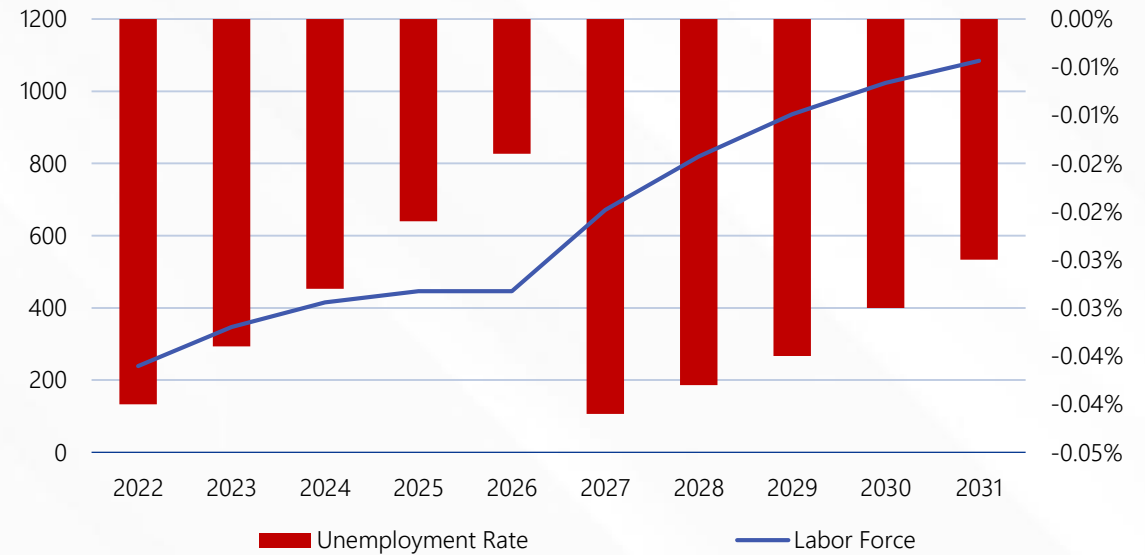# Bus Electrification (continued)

Equity Contributions (continued)
— A larger labor market with diverse demographic groups
— An expanded labor pool with the unemployment rate dropping by 0.03% on average
— Higher labor participation rate for all races/ethnicities, especially White and Black workers

Participation Rate by Race/Ethnicity
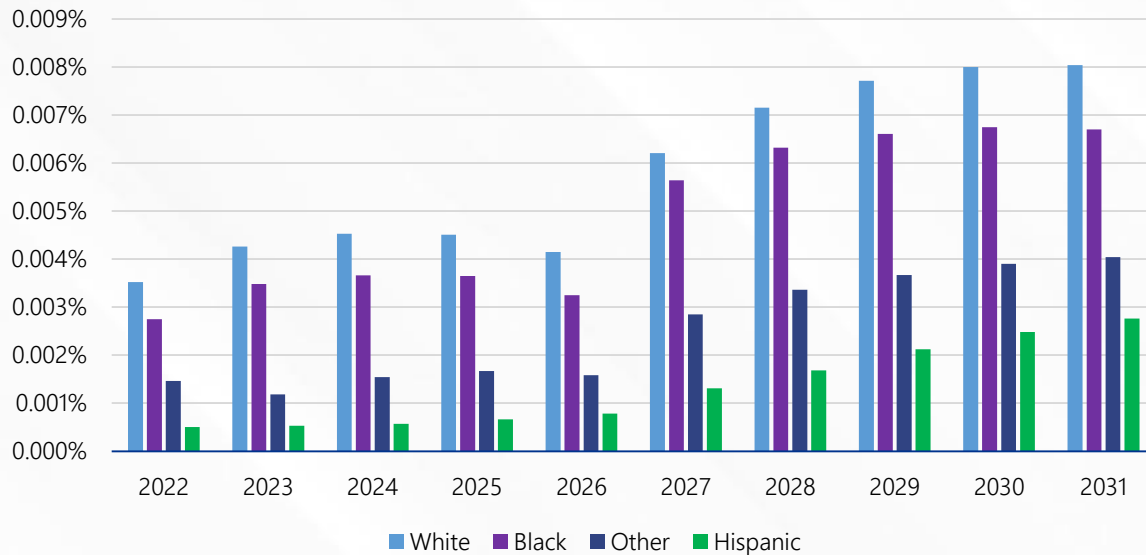
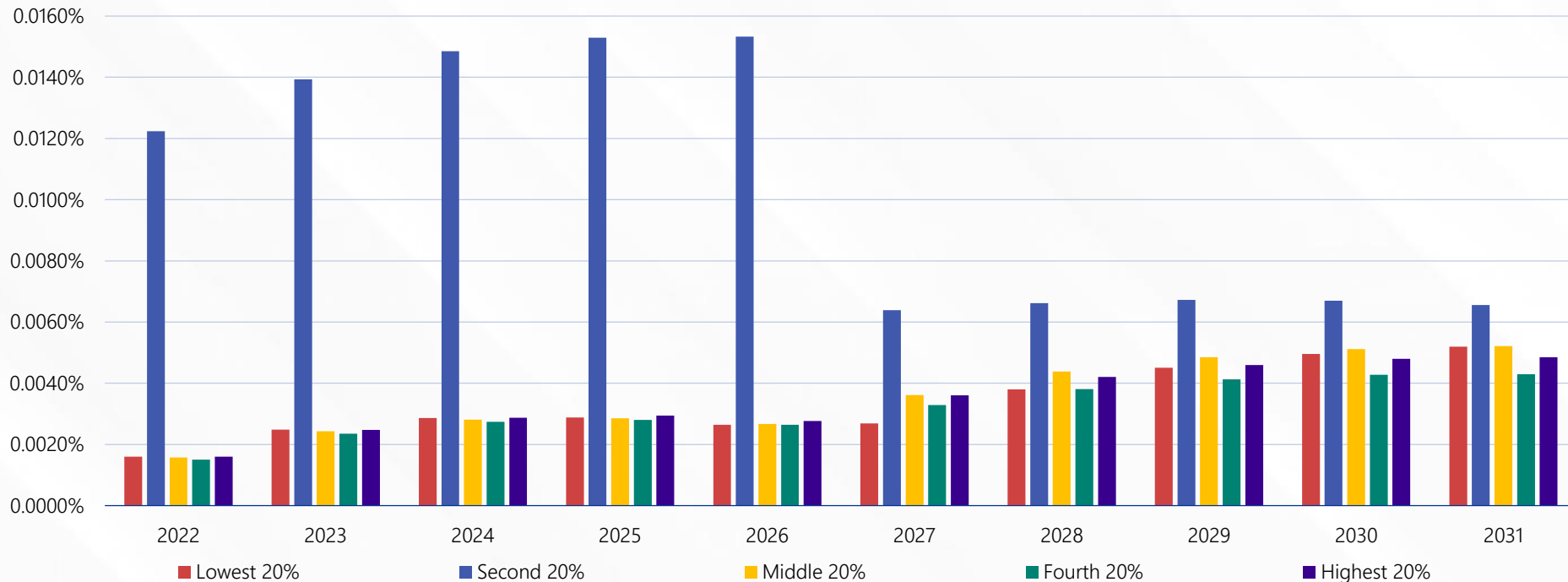Change in Labor Force and Unemployment Rate

Bus Electrification (continued)

Equity Contributions (continued)
— Higher compensation rate for all income groups
— Largest growth for the second quintile ranging from 0.012% to 0.015%, which includes the construction sector, during the construction period
— More evenly distributed among quintiles after construction, buoyed by improved labor access
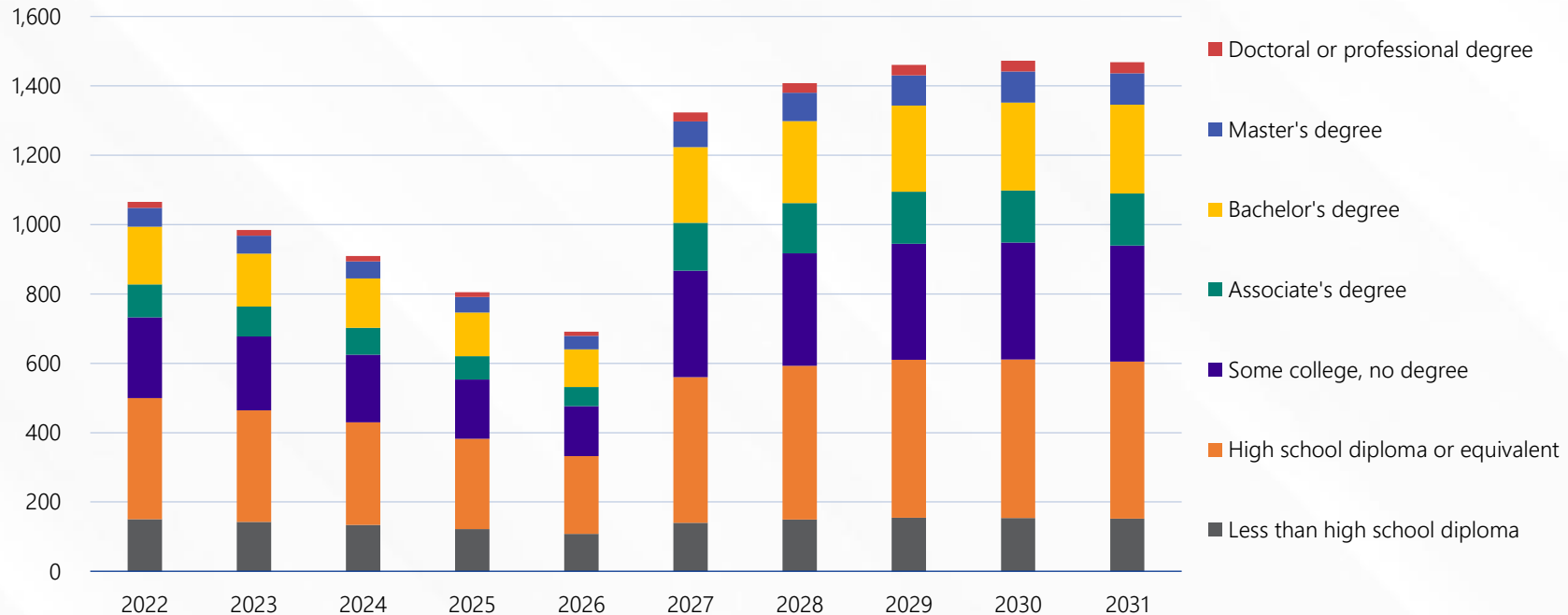
Compensation Rate by Income Quintile

Legend: Lowest 20% · Second 20% · Middle 20% · Fourth 20% · Highest 20%

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Bus Electrification (continued)

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Workforce Development Contributions

— More job opportunities for workers with at most a high school degree
  - By 2031, about 400 jobs would be added for workers with a high school degree

— 76.1% of the newly employed will not need a bachelor's degree (relative to 62.5% of the overall workforce)

**Additional Jobs by Educational Attainment**

Legend:
- Doctoral or professional degree
- Master's degree
- Bachelor's degree
- Associate's degree
- Some college, no degree
- High school diploma or equivalent
- Less than high school diploma

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Bus Electrification (continued)

Environmental Contributions

— Lower CO2 emissions: $1.5 million in annual monetized benefit (25,403 metric tons) on average, and approaching $2 million by 2031

— Largest reduction in diesel fuel, which results in $2.02 million average monetized benefit

CO_2 **Emissions Avoided ($)**

Legend: Natural Gas, Diesel, Electric, Total

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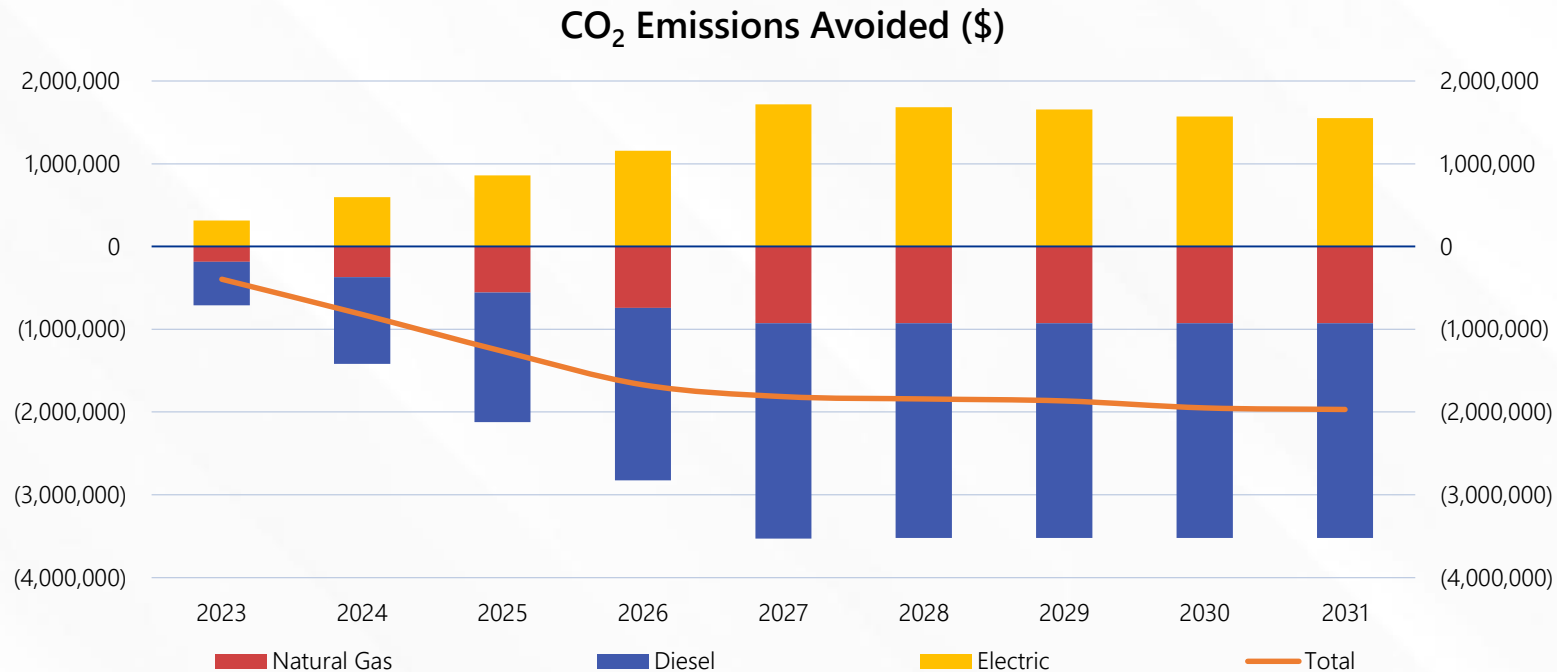
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Comparison of Scenario Outcomes

	Bus Electrification		Fixed Guideway Transit	Bicycle Infrastructure
	Construction and O&M Only	Full Scenario		
Net Capital Cost ($M)	$1,983	$1,983	$489	$833
Net O&M Cost ($M)	$179	$179	$1,299	$0
Total Cost ($M)	$2,161	$2,161	$1,788	$833
Contributions				
Jobs created (total, job-years)	8,122	11,590	32,748	7,819
Jobs created (annual average)	812	1,159	3,275	782
Share of jobs without Bachelor's degree	78.59%	76.14%	74.72%	78.08%
Share of jobs benefiting ethnic/racial minorities	49.04%	50.04%	64.60%	49.27%
Increase in GRP ($M)	$858	$1,306	$3,297	$830
Increase in Disposable Personal Income ($M)	$515	$980	$1,924	$515
Emissions Avoided (monetized average)	$1,500,000	$1,500,000	$750,000	$310,000
Emissions Avoided (monetized, 2031)	$2,000,000	$2,000,000	$839,000	$600,000
Contributions per Dollar Spent				
Jobs created per $1 million in spending	3.76	5.36	18.31	9.39
GRP per dollar spent	$0.40	$0.60	$1.84	$1.00
Labor Income per dollar spent	$0.24	$0.45	$1.08	$0.62
Average wage per job created	$63,408	$84,556	$58,752	$65,865
Emission reduction efficiency	0.093%	0.093%	0.026%*	0.072%
Emission reduced per $1 million in spending, 2031	$925	$925	$255*	$720

* Emission reduction efficiency calculation includes total capital costs of $1.99 billion

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Thank you for attending!

For more information, please contact
info@remi.com

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