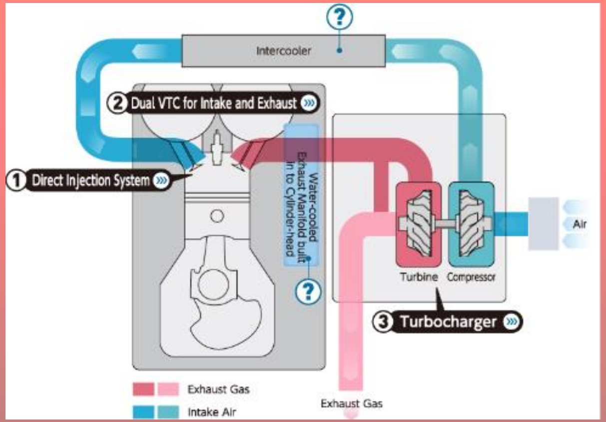
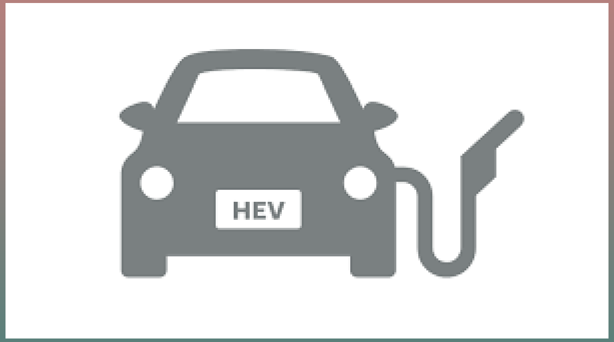
Energy Efficient Light Duty Vehicles

The Drawdown Georgia team broadly defines this solution set to include technologies that contribute to improved energy efficiency in light duty vehicles (LDVs), such as cars and pickups. A range of relatively mature and cost-effective technologies are available to reduce or replace petroleum fuel use in LDVs.

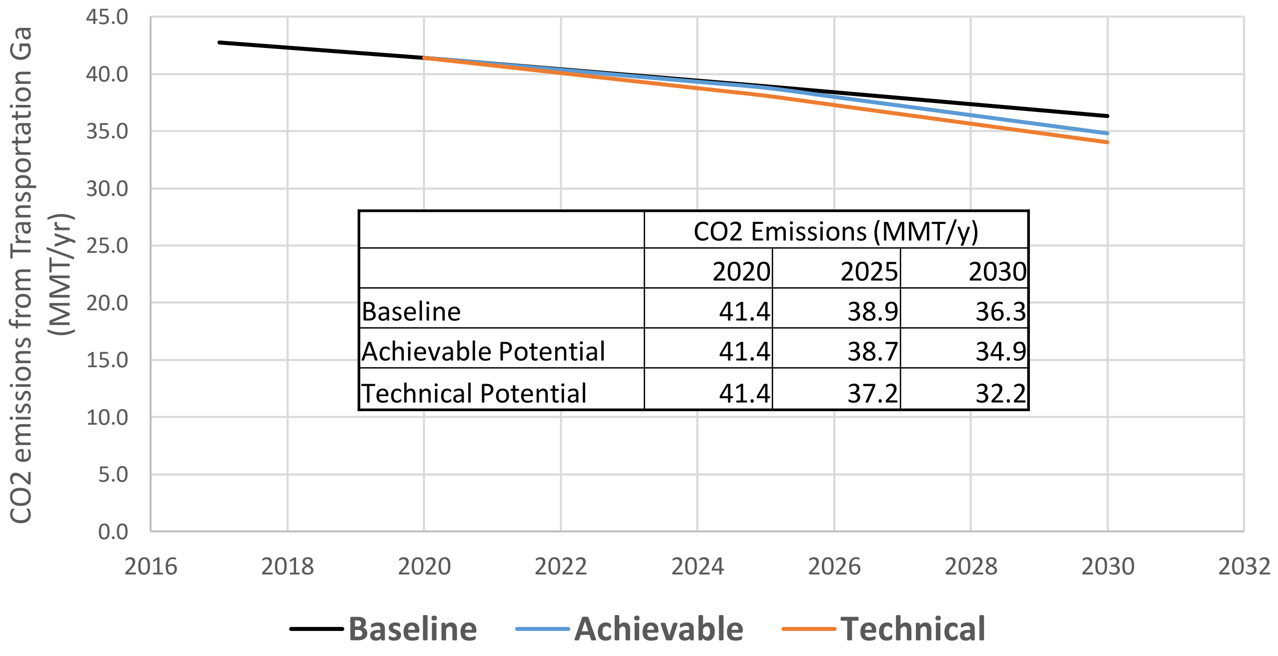
This solution primarily includes technologies that ***reduce*** conventional fuel use (such as turbochargers and hybrid powertrains). To a lesser degree, additional technologies are considered that ***replace*** fuel with alternative energy sources (such as CNG). Electric Vehicles are addressed separately in Drawdown Georgia as a stand alone solution. The trajectory and quantity of CO_2 reductions for conventional energy efficiency technologies is similar to EVs, and the two solutions can be complementary.





Energy Efficiency Light Duty Vehicles

Energy Efficient passenger cars and trucks are on steadily declining CO_2 trajectory to 2030



	CO2 Emissions (MMT/y)		
	2020	2025	2030
Baseline	41.4	38.9	36.3
Achievable Potential	41.4	38.7	34.9
Technical Potential	41.4	37.2	32.2

Baseline = Assumes business as usual for fuel economy and CO2 reductions, driven by new vehicle technologies and Federal CAFÉ regulations

Achievable Potential = -1.4 $MTCO_2/y$ While the Light Duty Vehicle (LDV) fleet is on a steady CO2 decline, a modest fuel economy improvement of 4% above the baseline is achievable by 2030 at low relative cost.

Technical Potential = -4.1 $MTCO_2/y$ Energy Efficiency technologies in the GA LDV fleet are extremely scalable. Deeper penetration rates of known and affordable measures, with an renewable emphasis on light trucks and SUVs, can drive double digit reductions in fleet CO2 by 2030.

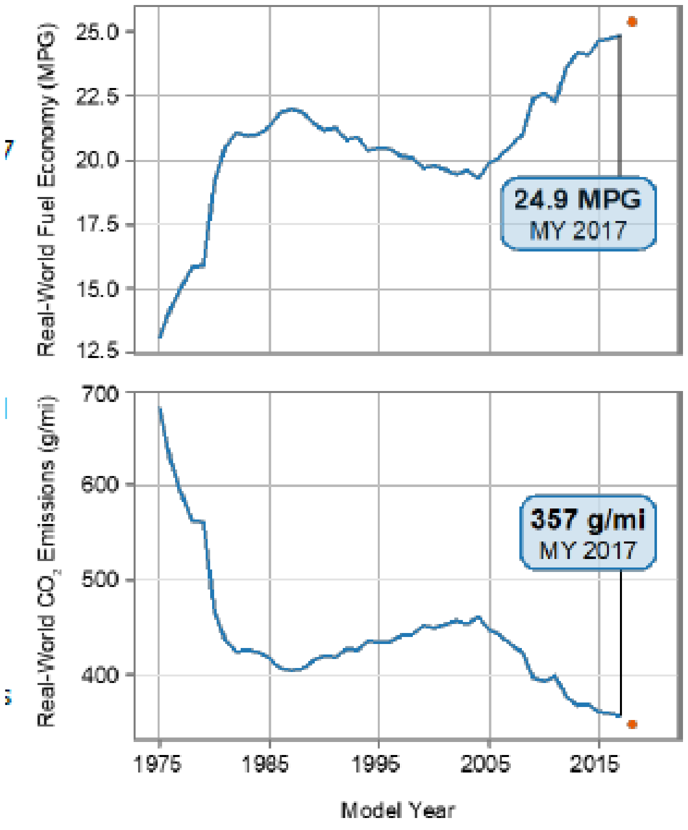
1 $MtCO_2e$ solution in 2030 = Average vehicle emissions for new cars in 2030 need only be 3% lower than the baseline to shed 1 $MtCO_2e$.

+Improved Air Quality
+Scalable and Available to All Vehicle Classes
+Promotes innovation, investment and jobs

-Cost premiums may become excessive toward 2030 (i.e., fuel savings will not be justified by upfront $)

Dramatic Progress in LDV Energy Efficiency since 2010

Figure 2.1. Estimated Real-World Fuel Economy and CO_2 Emissions



Source: 2018 EPA Automotive Trends Report

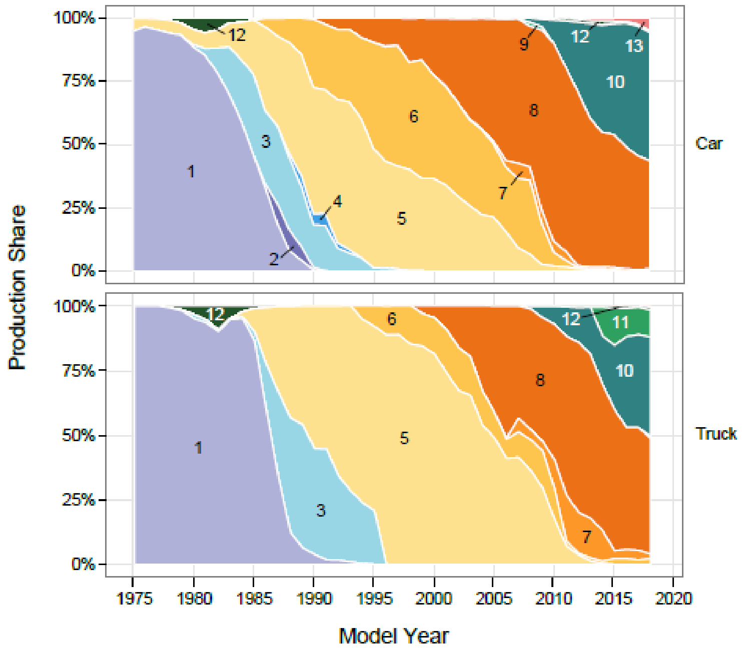
Driven by Aggressive Federal Corporate Average Fuel Economy (CAFÉ) regulations, Fleet Fuel Economy has increased more than 25% in the past decade.

A range of affordable technologies has underpinned this progress.

With the latest extension of CAFÉ regulations, conventional vehicles are required to continue improving at 1.5% y/y through 2025

Thus, the GA 2030 baseline for LDVs will be more than 5Mt (13%) lower than 2020 levels.

Figure 4.3. Production Share by Engine Technology

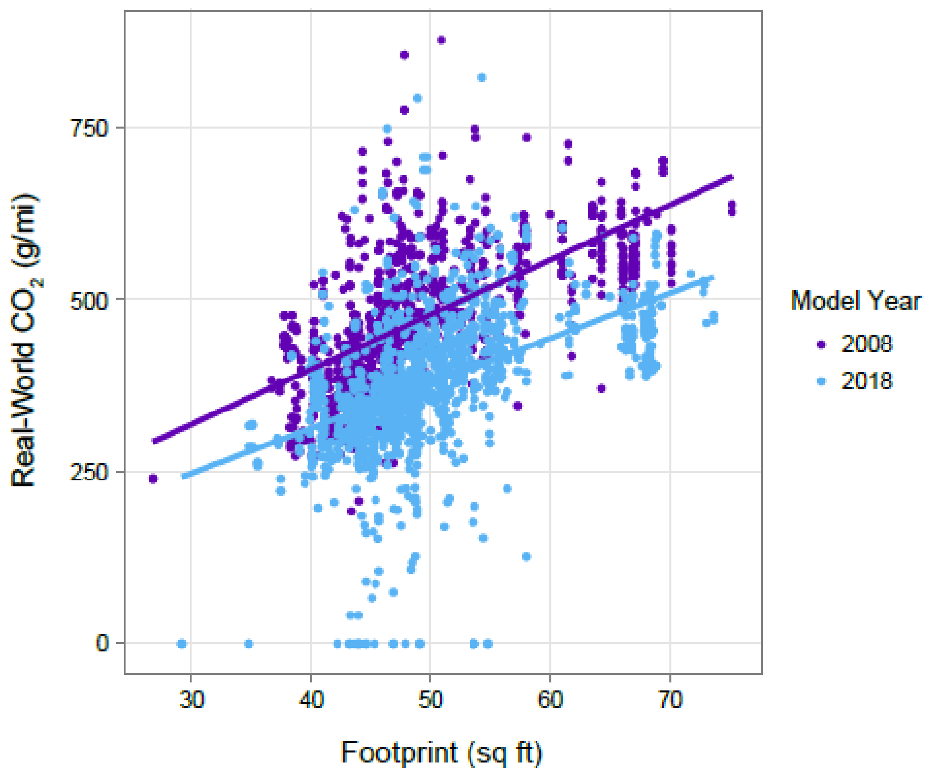


Fuel Delivery	Valve Timing	Number of Valves	Key
Carbureted	Fixed	Two-Valve	1
		Multi-Valve	2
Throttle Body Injection	Fixed	Two-Valve	3
		Multi-Valve	4
Port Fuel Injection	Fixed	Two-Valve	5
		Multi-Valve	6
	Variable	Two-Valve	7
		Multi-Valve	8
Gasoline Direct Injection (GDI)	Fixed	Multi-Valve	9
	Variable	Multi-Valve	10
		Two-Valve	11
Diesel	—	—	12
EV/PHEV/FCV	—	—	13

https://www.epa.gov/automotive-trends/download-automotive-trends-report#Full%20Report

Near-linear correlation between CO2 and vehicle size: Implications for Georgia

Figure 3.14. Relationship of Footprint and CO_2 Emissions



Source: 2018 EPA Automotive Trends Report

https://www.epa.gov/automotive-trends/download-automotive-trends-report#Full%20Report

Naturally, CO2 emissions are (nearly linearly) correlated to vehicle size and weight.

In Georgia, the share of the LDV fleet that is comprised of larger vehicles (light trucks and SUVs) is about 60% compared to a national average share of about 45%.

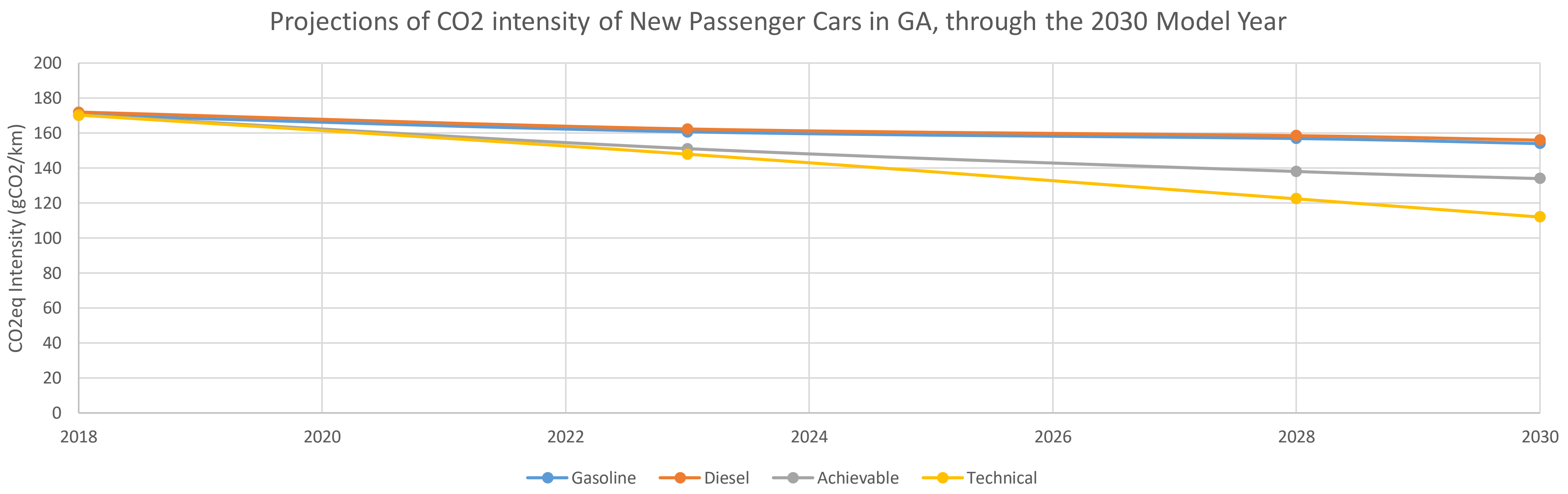
This results in a disproportionate level of emissions from these larger passenger vehicle classifications.

On the plus side, new fuel-saving technologies are now penetrating larger vehicles, and can contribute to substantial CO2 reductions over the coming decade.

Nonetheless, vehicle fleet mix will remain a critical parameter in Georgia that has implications about behavior, consumer choice, and use.

Future CO2 trends for new LDVs, through 2030

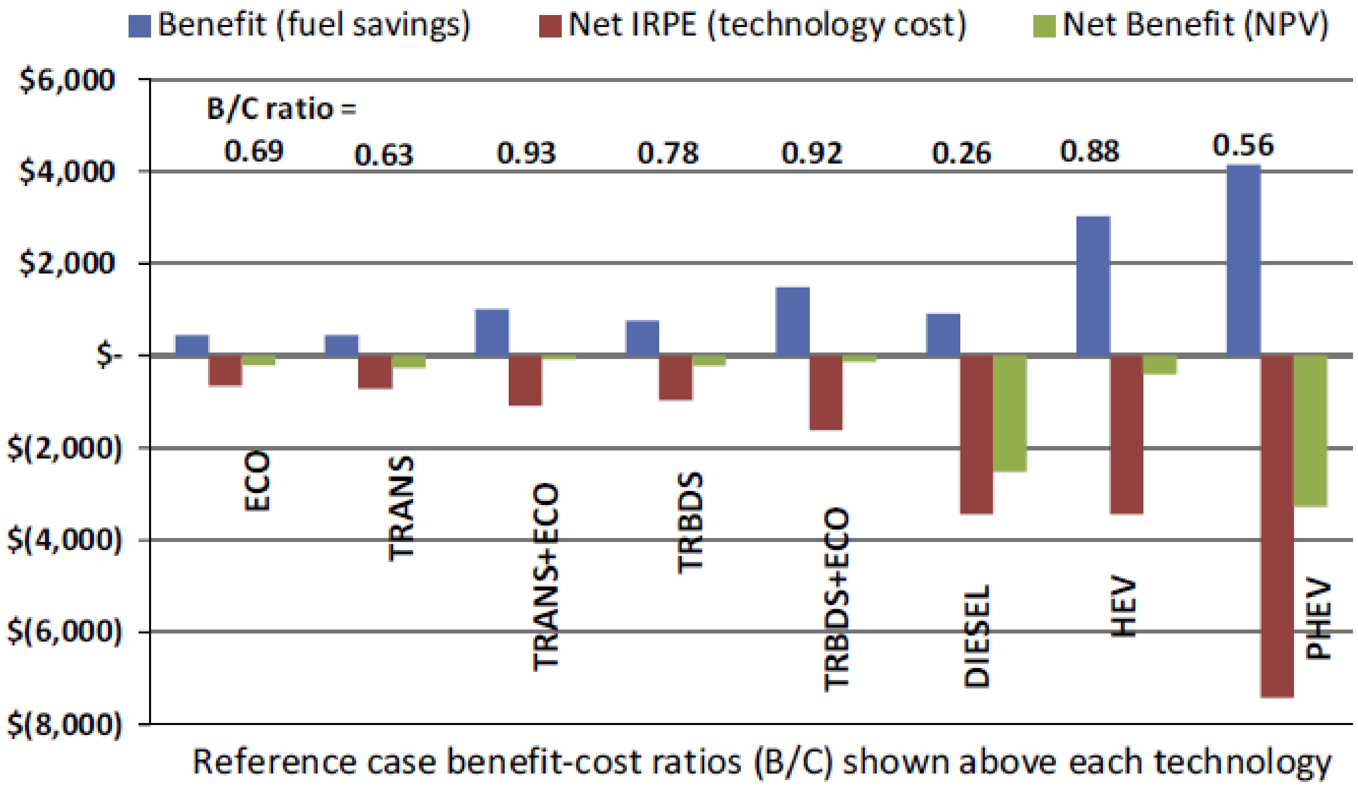
- Achievable solution corresponds to an equivalent CO2 intensity of:
  - 136 gCO2/km for new MY2030 cars and
  - 190 gCO2/km for new MY2030 SUVs and pickups



However, since vehicles are in the fleet an average of 16 years, annual turnover is only about 6% per year, meaning change happens slowly, in spite of rapid penetration of highly efficient new models.

R. Simmons, Strategic Energy Institute, Georgia Institute of Technology, 2020

Benefits and Costs of Fuel-Saving LDV Technologies



Simmons, Richard A., et al. "A benefit-cost assessment of new vehicle technologies and fuel economy in the US market." *Applied energy* 157 (2015): 940-952.

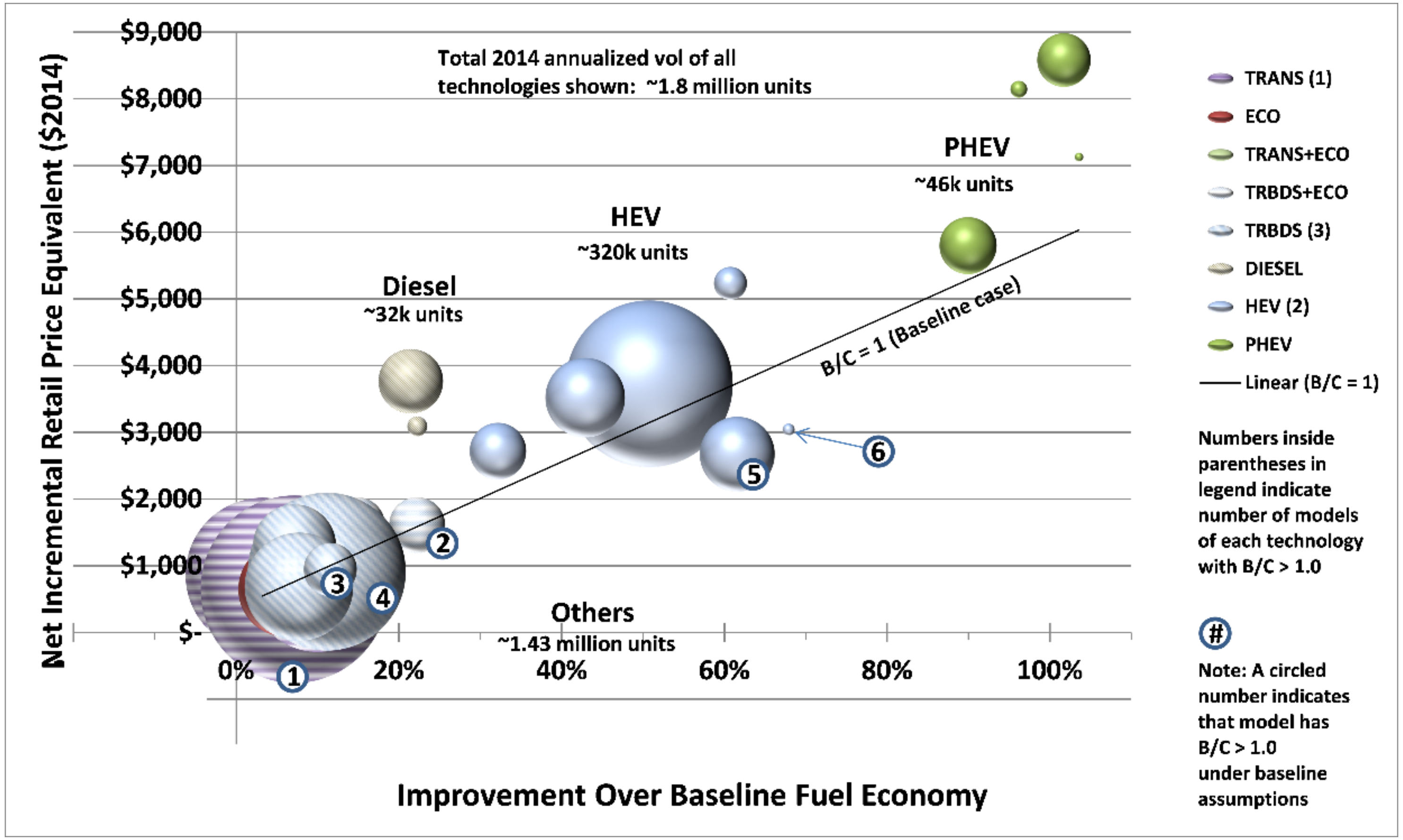
Under current assumptions for fuel price, vehicle miles traveled, and interest rates, today's consumers are unlikely to see a compelling payback on fuel efficiency technologies, on their own merit. In other words, fuel savings over time are currently less than upfront technology costs.

However, many new technologies provide additional performance benefits (e.g., acceleration, torque from rest, reduced maintenance), and can compel buyers to invest in higher efficiency.

Progress toward 2030 targets will depend on several unknown variables

- Cost of conventional fuel
- Penetration into trucks and SUVs
- Future CAFE regulations

Benefits and Costs associated with Fuel-Saving Technologies in LDVs



Simmons, Richard A., et al. "A benefit-cost assessment of new vehicle technologies and fuel economy in the US market." *Applied energy* 157 (2015): 940-952.

This plot shows where key fuel efficiency technologies lie on a benefit/cost spectrum.

Technologies that lie below the breakeven (B/C=1) line will provide a positive economic return to consumers. For prolonged adoption of more energy efficient cars, consumers will need to reconcile costs, and/or be motivated by other factors.

Financial viability and progress toward 2030 targets deriving from energy efficiency investments in conventional vehicles will depend on several unknown variables

- Cost of conventional fuel
- Penetration into trucks and SUVs
- Future CAFE regulations
- Attractiveness of alternatives (e.g., EVs)

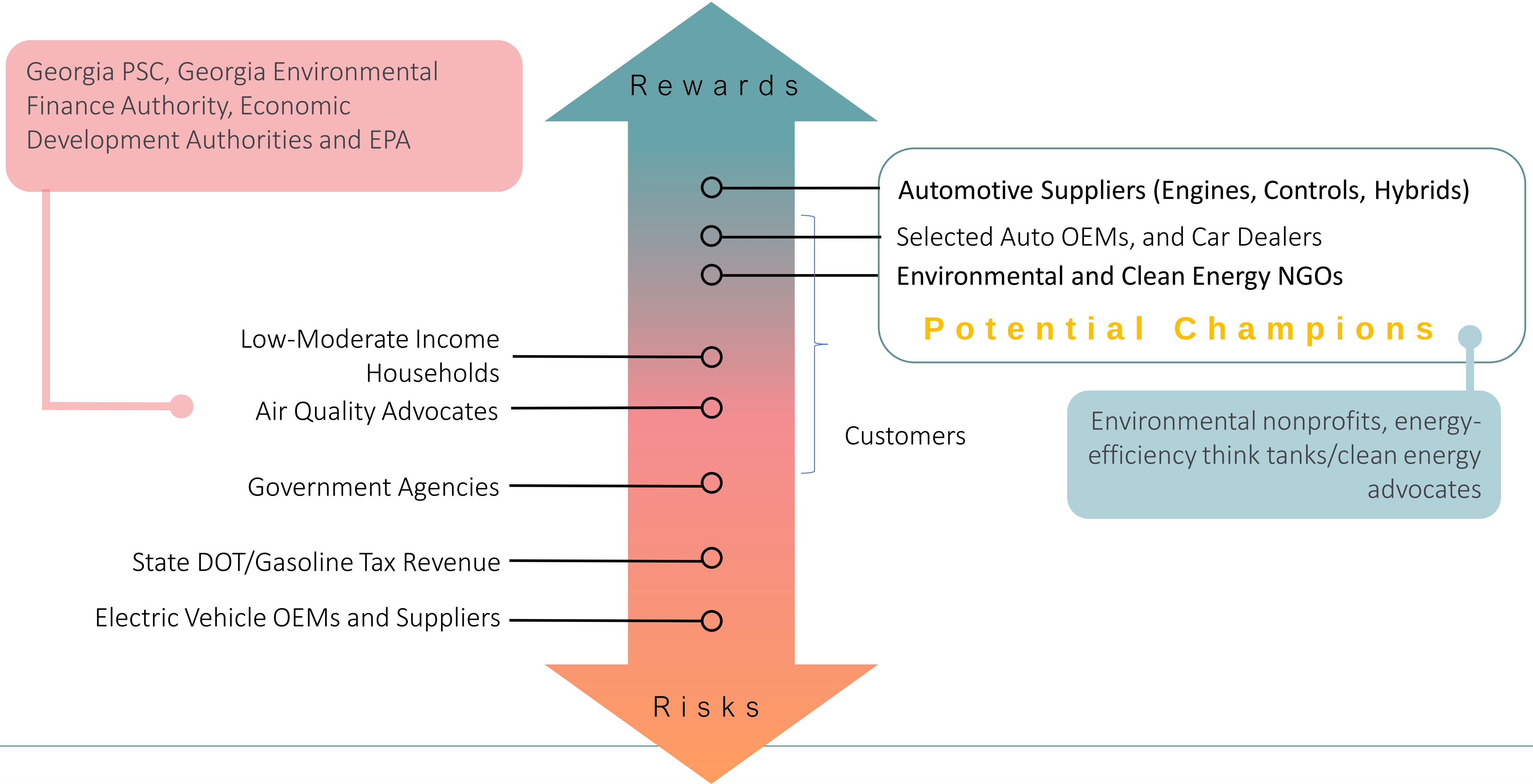
Beyond Carbon for Energy Efficient LDVs: Glimpse into Air Quality Changes

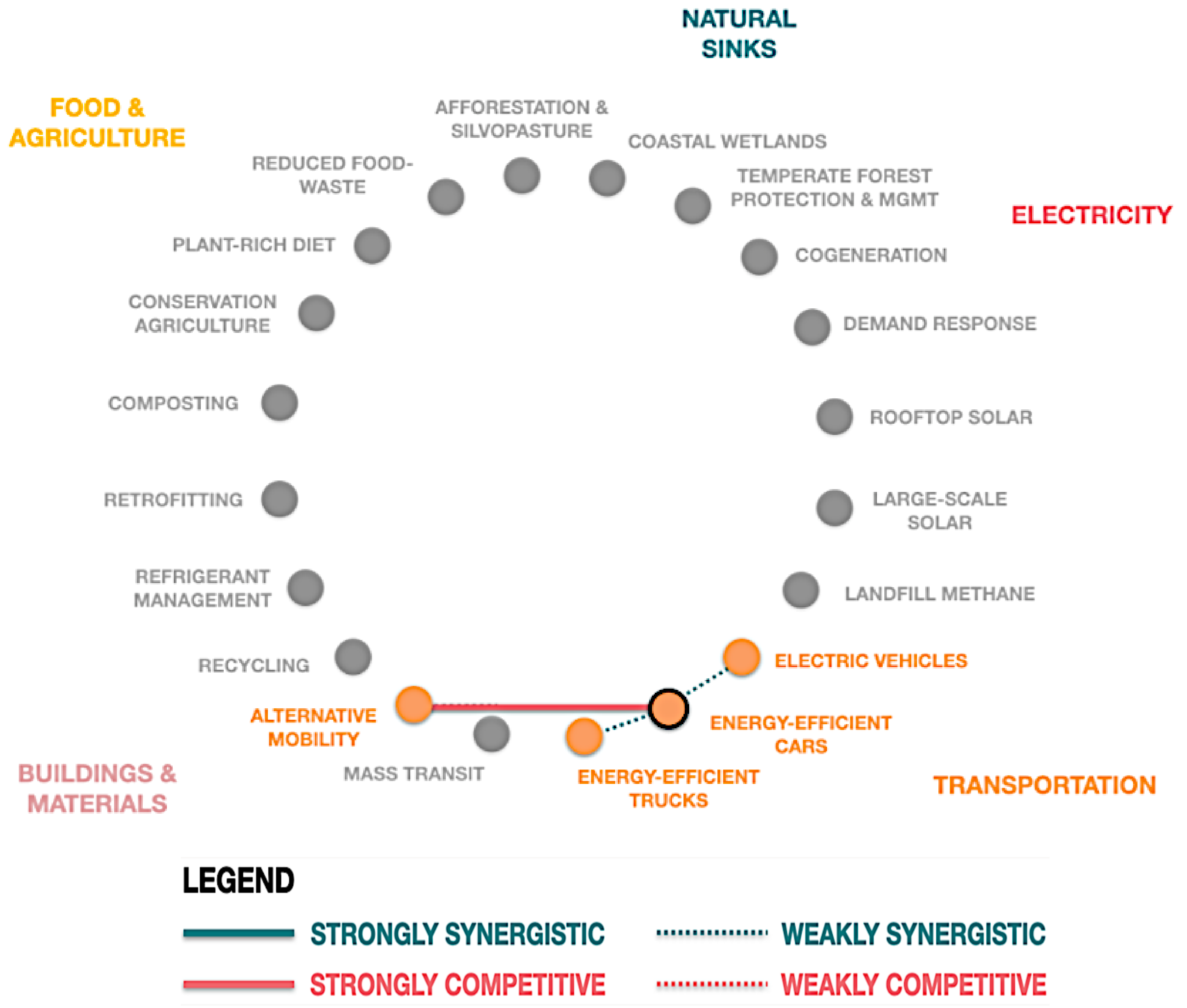
	NOX		2020	2030 Tailpipe Emissions	2030 Electricity Sector Increase	2030 Total	Net Change T/yr	Net Change %
Baseline	Total NOx Emissions, Ga LDV Fleet	Ton	10005	4175	124	4299	BASELINE	BASELINE
	NOx Intensity, GA LDV Fleet Avg	gNOx/mi	0.099	0.040		0.0405		
Achievable	Total NOx Emissions, Ga LDV Fleet	Ton		3969	124	4093	-206	-4.8%
	NOx Intensity, GA LDV Fleet Avg	gNOX/mi				0.0384		
Technical	Total NOx Emissions, Ga LDV Fleet	Ton		3674	124	3798	-502	-11.7%
	NOx Intensity, GA LDV Fleet Avg	gNOX/mi				0.0374		

A few key takeaways, based on the change in NOx tailpipe emissions for new LDVs:

- Baseline is headliner: NOx emissions for new cars will decline by more than half in the coming decade
- With minimal new adoption of EVs, energy efficient cars and trucks can contribute an additional 5-12% reduction in tailpipe NOx relative to the 2030 baseline.
- Other tailpipe emissions reductions (except PM) have similar trajectories as they are loosely proportional to CO2.

Stakeholder Analysis of Energy Efficient LDVs




NATURAL
SINKS
FOOD &
AGRICULTURE
AFFORESTATION &
SILVOPASTURE
COASTAL WETLANDS
REDUCED FOOD-
WASTE
TEMPERATE FOREST
PROTECTION & MGMT
ELECTRICITY
PLANT-RICH DIET
COGENERATION
CONSERVATION
AGRICULTURE
DEMAND RESPONSE
COMPOSTING
ROOFTOP SOLAR
RETROFITTING
LARGE-SCALE
SOLAR
REFRIGERANT
MANAGEMENT
LANDFILL METHANE
RECYCLING
ELECTRIC VEHICLES
ALTERNATIVE
MOBILITY
ENERGY-EFFICIENT
CARS
MASS TRANSIT
ENERGY-EFFICIENT
TRUCKS
BUILDINGS &
MATERIALS
TRANSPORTATION
LEGEND
STRONGLY SYNERGISTIC
WEAKLY SYNERGISTIC
STRONGLY COMPETITIVE
WEAKLY COMPETITIVE

Energy Efficiency LDVs

A solution for Georgia that:

- Reduces carbon emissions
- Is readily scalable
- Results in air quality benefits
- Can be pursued concurrently with EVs
- Can generate new jobs

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